Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XL. No. 20. NEW YORK, SATURDAY, MAY 17, 1902. ISSUED WEEKLY

ELECTRICAL REVIEW
PARK ROW BUILDING
13-21 PARK ROW - - NEW YORK
P. O. BOX 339

BY THE
ELECTRICAL REVIEW PUBLISHING COMPANY
CHARLES W. PRICE
PRESIDENT AND TREASURER
STEPHEN H. GODDARD
SECRETARY AND MANAGER
CHARLES T. CHILD
TECHNICAL EDITOR
RUSSELL HOWLAND
GENERAL REPRESENTATIVE

WESTERN OFFICE
40 DEARBORN STREET, CHICAGO
LONDON OFFICE
42 OLD BROAD STREET, LONDON, E. C.

REGISTERED CABLE ADDRESS
"ELECTVIEW" - - NEW YORK
TELEPHONE CALL, 21 "CORTLANDT"
(PRIVATE BRANCH EXCHANGE CONNECTING ALL DEPARTMENTS)

SUBSCRIPTIONS TO THE
ELECTRICAL REVIEW
One Year, United States and Canada - - - $3.00
One Year, Foreign Countries - - - - - 5.00
Single Copies, each - - - - - - - - 10
Copies can be supplied for only one year back at 25 cents each.

TO ADVERTISERS
CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

The programme for the meeting of the National Electric Light Association, which is to be held in Cincinnati during the coming week, is one that promises to make that occasion of importance and value to all those who attend the meeting or subsequently read the papers. The topics for discussion are timely and interesting, and those who have been selected to comment upon them represent the ablest intelligence and the largest experience in the line of their work. It is confidently believed that the past history of these meetings will repeat itself at Cincinnati, and that the occasion will be one not only of extreme interest, but of high value as well.

THE VALUE OF ELECTRIC LIGHTING.

Primitive man was a creature of circumstances. His hours of activity and rest were sharply marked by the rising and setting of the sun. The invention of artificial light gave almost a new life to the race. It increased the working capacity of mankind and also, by providing a possibility for social and domestic intercourse after working hours, immensely accelerated the progress of civilization and of all the arts.

When we reflect upon the kinds of lights with which our ancestors struggled along, the evenings dragging to bedtime by the uncertain flicker of candles and of smoking lamps, we can understand with what acclaim gas was welcomed when, early in the last century, it was first put to work as an illuminant. Contemporary records dwell at some length upon the danger to the eyesight due to the use of this overpoweringly brilliant illuminant! Social affairs took on a new and added lustre and, for the first time, streets began to be illuminated. Hitherto the oil lantern at street corners had served rather as a guide-post for the belated traveler than for an actual source of illumination.

The difference between the appearance of cities and shops and stores and of residences after nightfall between the day of gas and lamps and the present will be remembered by many of the older generation. The introduction of electric street lighting accomplished a number of astonishing results that were entirely unexpected. It was noticeable immediately in cities that nocturnal crime had diminished. Light is a powerful enemy to deeds of darkness. It was stated by the chief of the New York police force, shortly after the general introduction of arc lamps on the streets, that one electric lamp was worth two policemen for the protection of property and as a deterrent of crime after nightfall. Similarly many accidents due to the former darkness of streets disappeared, and the conditions of life in cities after dark were made safer and more comfortable.

What the electric light has done for indoor illumination is of vast importance. By removing the unsanitary and unclean gas jet it has secured in homes, workshops and places of public assembly not only a better and steadier light but also a far more healthful atmosphere, with a resulting effect that is already beginning to show in mortality statistics. The facility with which incandescent lights lend themselves to decorative effects has introduced a new art in the decoration of interiors and exteriors of buildings, and the wide use of such lights in illuminating signs has contributed vastly to the general illumination of streets. Never before in the history of the world has any thoroughfare been so magnificently lighted as is upper Broadway, in New York city, by virtue of the electric signs which practically abolish shadows and turn night into day upon that thoroughfare.

By suppressing the open flame of gas and lamps the use of electric light has diminished fire hazards, and it has incalculably saved property and life. Indeed, it has made certain kinds of lighting possible which would not have been even considered without its invention. Work can be conducted in dangerous coal mines with ease by its use, and it is even used to illuminate powder magazines.

But perhaps of all the good that has been accomplished by the general introduction of electric lighting, none is greater than the general and widespread benefit that it has exerted upon conditions of life and mental activity. By providing a thoroughly satisfactory illuminant for the dark hours it has enabled study, recreation and work to go on unimpeded. The productive power of workshops has been largely increased by the possibility of

night work, which could not be conducted with satisfaction under the unsteady and unsatisfactory illumination of gas and lamps. The saving in eyesight, which has come through its use, is one of the things that should not be left without consideration, while in many communities, especially newer ones, the deadly and dangerous gas-pipe is unknown, and thus a serious menace to life and health and property is removed. Taken altogether, electric lighting has probably done as much for civilization and for the general well-being of humanity as any other single invention.

POWER TRANSMISSION AND INDUSTRIAL ACTIVITY.

The electrical transmission of power to considerable distances has accomplished not only results not contemplated in its original inception, but also others of widespread importance and value. Indeed, the secondary results are quite as important as those arising from the primary successful operation of such transmission lines. Wherever a water-power exists, or where other situations enable power to be cheaply produced, there has lain dormant a source of actual wealth which has awaited the application of electricity. The effective results obtained when powers have been developed and applied by this means have been almost invariably alike. New industries have started, new towns and villages have grown up, and new centres of production have arisen and given employment to labor and afforded a market for raw materials. From the combination of the two there has arisen in each case a new source of manufactured products representing an addition to the permanent wealth of the country. Even, however, beyond these industrial effects, which have been noted in the case of power transmission establishments in certain portions of the United States, other results quite unexpected and equally as beneficial have arisen.

In the arid regions of the West, where only irrigation is needed to cause the soil to become highly productive, the installation of plants for the distribution of water to the dry soil has often caused the development of water power in considerable quantities available for electrical transmission. Conversely, the development of water powers has not infrequently made irrigation comparatively easy and a possible addition to the general plan of improvements proposed. In California the setting to work of the waterfalls has been accompanied also by the release of the water in many cases to the dry lowlands, and the interesting spectacle is presented of a new source of power, producing new manufacturing establishments, and equally an influx of population, and at the same time a vitalizing of the soil to such a degree as to enable it easily to support this increased population. Truly these plants in many cases have made the desert into a garden and opened up productive centres of the best possible influences.

At Niagara Falls the harnessing of the water of the great cataract has changed the whole aspect of the town—changed it from a show village, whose principal industry was the entertainment of the stranger, into a prosperous manufacturing community where thousands of operatives are paid for productive work. The transmission of this power to Buffalo has introduced entirely new conditions into the manufacturing activities of that city and has already had an important bearing and effect upon its commercial status.

In South Carolina waterfalls that for all the centuries since the country was explored have tumbled uselessly down mountain sides, have been set to work turning the spindles and looms of cotton mills and forming a centre of production of high importance, both to that state and to the country at large. In every instance where electrical transmission has been called into play for the utilization of new powers or powers hitherto undeveloped the general social effect has been good.

It is believed that in the future these installations and these industries will play no unimportant part in the general development of the country. The water-power resources of the United States have been by no means fully developed, and while there is perhaps less incentive here than in other countries less favored by nature with abundant coal deposits, still the final utilization of every drop of falling water that can be set to work is inevitable. Where it was impossible formerly to take manufacturing enterprises into the wilderness where the water power is located, to-day it is feasible to take the power out of the wilderness and bring it to the town and, by the use of electrical transmission, to coordinate all the advantages of shipment and access to raw materials and to labor, a situation hitherto impossible when works were perforce built alongside of the waterfalls that furnished their energy.

THE POSSIBLE INFLUENCE OF AMERICAN STUDENTS UPON OXFORD UNIVERSITY.

More and more as time goes on it is being realized that the engineer, that is, the man who does things, the man who seizes and uses the powers of nature, and who produces results, is the leader of advancement and the missionary of civilization. The student, as such, the Oxford don, the contemplative person, is becoming more and more remote and being left farther and farther behind in the swift advance of modern things. Whether or not this is desirable, or whether we are not afflicted with too much strenuousness and too great a desire for achievement, *per se*, may not be discussed here; but whether the value of Mr. Rhodes's princely endowment, under the terms of which American students are to be educated at Oxford and there saturated with the scholastic tradition of that university, will be as great as its author thought it would be is certainly open to some question. To-day it is doubtful if any young man going to Oxford from the United States would find the advantages he leaves behind. To-morrow, it may be that the influx of new students with new ideas from newer countries may cause a revolution in the methods of teaching and the methods of thought of Oxford itself, and perhaps out of a combination of dignified tradition and energetic, progressive vitality thus engendered may come something better than anything that has yet been seen in educational institutions. We may at least hope that this will be the case and that the lavish millions which Mr. Rhodes has left will not be wasted.

WIRE SUBWAYS.

When it was first found that it would be necessary, from the constantly increasing and growing business of electric light and telephone and telegraph companies, to put conducting wires underground, the duct conduit in one form or another was evolved, largely under the pressure of necessity. Perhaps the first underground electric light circuit was that put down in Chicago by Mr. John P. Barrett, the city electrician, for conducting an arc light circuit, in the year 1886. This conduit consisted of an iron pipe in which a cable, made much after the fashion of a submarine cable and covered with a lead armor, was laid. In New York the tubes put down by the original Edison installation, consisting of iron pipes carrying permanent copper conductors insulated by a tarry compound, were among the first and shortly afterward large quantities of wooden conduit, either consisting of pump logs or of boards recessed and beveled to form conduit when put in position, were installed. It would require too much space even to catalogue the varieties of conduit that have been invented and tested in practice. Sheet-iron pipes lined with cement concrete, ducts formed in massive concrete by various processes, clay tiles and pipes of various kinds and shapes, iron pipes, and a large number of other structures have all been tried and all been found good under various conditions and circumstances.

With the growth of cities, however, and the continual expansion of electrical businesses of one sort and another, conduits have grown and multiplied and underground construction has occupied no inconsiderable part of the streets. It has practically been impossible at all times to foresee the growth and increase in this variety of construction. For this reason in many streets the conduits have had, from time to time, to be enlarged, necessitating the disturbance of the street surface, the interruption of traffic, and very large expense. In New York alone at least a dozen plans have been made public for the construction of a permanent subway for the reception of electrical conductors and pipes, most of these schemes being brought forward in connection with plans for rapid transit underground railways. Unfortunately when the present rapid transit subway was finally planned and work upon it begun, no very adequate provision was made for underground wires and pipes and it is likely that New York will see for a long time to come a repetition of the continual opening of the streets and enlargement of conduit systems.

In Chicago, however, a very radical solution of this problem has been undertaken and a tunnel of generous dimensions—in fact, nearly as large as a railway tunnel—is being constructed, with numerous ramifications, through the business district for the sole purpose of affording a place for conducting wires. In this respect Chicago is perhaps more fortunate than any other city, unless it be Paris with its magnificent system of sewers affording ample room for electrical conductors of all kinds. In our greatest cities the question of underground electrical construction is assuming a phase of great importance. The work of telephone companies has been no little hampered by the small sizes of ducts laid down in original installations. Telephone cables of sizes larger than those now in general use could be handled very satisfactorily if the ducts were big enough to permit their installation. It is hoped that if any extension is ever made to the underground rapid transit system in New York, ample provision will be made coincidently for wires. The cost would not be excessive and the saving both in actual money and in convenience to the citizens of the city would be enormous.

ELECTRIC ELEVATORS AND THE CENTRAL STATION.

One of the most profitable and generally satisfactory classes of business that comes to central stations is the electric elevator. With improvements in the architecture, or rather in the manner of construction, of buildings and the increase in value of real estate in most of our cities the tendency has been noticeable to build higher and higher, thus requiring the installation of elevators in practically all new business buildings of any importance. The electric elevator itself has been carefully worked out by competent engineers and manufacturers until it is a thoroughly serviceable and satisfactory piece of apparatus. In the majority of cases the elevator load is distributed throughout the daytime and goes off coincidentally with the coming on of the lighting load at night, so that the elevator offers the station a highly attractive source of outlet for its daytime power.

There has been more or less discussion in the past, and probably will be more in the future, concerning the availability of alternating-current motors for elevator purposes and the ability of alternating-current stations to give patrons good elevator service. This discussion, while of great technical interest, has no particular bearing upon the problem, since in the crowded business districts of most of our cities direct-current supply by means of substations could easily be arranged in view of the exigencies of the elevator situation. One thing is certain, that the number of elevators both for freight and passenger uses is increasing rapidly and will continue to increase for some time. The active station manager will do well to investigate the subject of elevators in his territory, and to stimulate by concessions of one sort and another the installation of these appliances wherever possible.

THE STEAM TURBINE.

On other pages of this issue will be found an illustrated description of the steam-turbine unit lately installed in the station of the Hartford Electric Light Company. The performance of this machine through its preliminary trials has been of such astonishing efficiency as to leave no doubt in the minds of the management of the station in which it is placed that it represents the coming type of apparatus for this purpose. In view of the results attained by it, of what it has done and what it promises to do, it will be interesting to note engineering opinion concerning some of the great power stations using reciprocating engines which have lately been constructed in New York and other cities after, say, ten years have passed. Meanwhile, the delegates at Cincinnati next week will find here an excellent topic for consideration.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LXII.

BY W. ELWELL GOLDSBOROUGH.

The foregoing matter illustrates sufficiently well the reactions which take place in alternating-current generators where the considerations are confined entirely to single-phase working. If we go a step farther and take up the study of the reactions which modify the

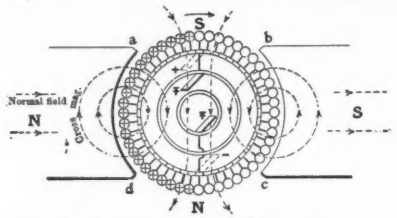


FIG. 152.—ALTERNATING MECHANISMS.

regulation of two and three-phase machines, we must determine somewhat more accurately the characteristics and nature of the quantity which, thus far, we have termed the synchronous reactance of the armature and designated by the symbol x_a.

There are a number of points of similarity between the reactions which exist in direct and alternating-current armatures, and it will pay us to study these points somewhat at length while analyzing the quantity we now know as synchronous reactance with a view to applying the information gained thereby in an investigation of the theory of the working of all types of alternating-current generators.

By way of reducing our discussion to its simplest terms a bipolar direct-current armature supplied with two collector rings connected to diametrically opposite commutator bars may be considered. If direct currents are being taken from the machine and the commutating brushes are placed midway between the pole-tips, the reactive effect of the armature ampere-turns upon the field ampere-turns will be zero, although the cross-magnetizing effect of the armature ampere-turns will be a maximum. This is illustrated in Fig. 152.

If the commutating brushes are given a lead, as illustrated in Fig. 153, the reactive or demagnetizing effect of the armature ampere-turns upon the field circuit comes into prominence, while the cross-magnetizing effect is somewhat diminished. The aggregate armature reaction, however, is greatest for a given current flowing in the armature in the latter case. Suppose, now, an alternating current having a maximum value equal to the direct current above mentioned is taken from the machine by means of the collector rings. If we consider that the maximum value of the alternating electro-motive force is generated just as the commutator bars to which the collector rings are attached, or midway between the pole-tips (as would be the case at no load, see the discussion of Fig. 128, page 79), the cross-magnetizing armature ampere-turns would, at this instant, be the same as in the Fig. 152 position of the brushes when a direct current is drawn from the armature. This cross-magnetizing effect of the alternating current shifts the resultant field, due to the combined action of the alternating armature and field ampere-turns, in the direction of rotation of the armature, and tends to produce saturation in the trailing pole-corners *a* and *c*, just as do the cross-magnetizing armature ampere-turns when a direct current is taken from the armature; but, in the case of the alternating-current condition, the shifting of the field in the air-gap in the direction of rotation retards the rise of the alternating current to its maximum value until later in the revolution, say,

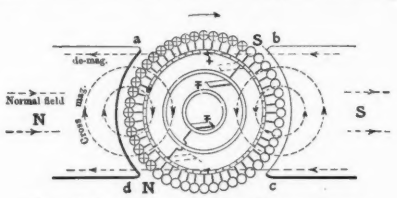


FIG. 153.—ALTERNATING MECHANISMS.

until the collector-tapped commutator bars are near to the leading pole-tips *b* and *d*. The maximum value of the current will then occur at such a time as to produce an effect analogous to the cross and demagnetizing effects caused by the lead given to the brushes in a direct-current dynamo, as illustrated in Fig. 153. From this it is evident that there is, in an alternating-current machine, a reactive effect emanating from the armature that both retards and shifts the air-gap flux in the direction of rotation. At the instant that the maximum induction is threading the alternating-current armature coil, the distribution of the magnetic flux in the air-gap most nearly approximates the normal, as at no load. As the current rises in the coil the effect is gradually to distort the field in the direction of rotation, first, by aiding the field ampere-turns, and then by exerting a cross-magnetizing action. These effects are most pronounced when the current is a maximum and diminish for decreasing values of the current as the coil moves forward. Just before the current becomes zero again, it acts directly in opposition to the field ampere-turns.

The effect, therefore, of the armature reaction in an alternator working under a non-inductive load is to diminish the virtual value of the electro-motive force and to retard the rise of the electro-motive force to its maximum value till later in the period. It consequently causes the electro-motive force to lag behind its normal no-load position. These facts have been developed in other words in connection with the discussion of Fig. 133, where it is shown that the resultant electro-motive force developed in the armature winding is equal to OC_0, when a current equal to OB is flowing.

In a commercial alternator, the armature reaction still further modifies the simple harmonic resultant of theory, as, owing to the saturation and bunching of the lines of force that take place under the trailing pole-corners, the rate of cutting of the lines of force by the armature coils is greater during the second and fourth quarters of a period, measured from the time of the rise of the electro-motive force from zero, in a positive direction, than in the first and third quarters, and the electro-motive-force curve is thereby somewhat distorted in the direction of rotation.

Many writers, in considering the reaction of the armature upon the fields, deem it advisable to treat the magnetizing effects of the components of the armature current which are in phase with and at right angles to the phase position of the no load or internal electro-motive force, separately. By this method of treatment, the effective component, OB_g, which is in phase with the total internal electro-motive force OA_0 of Fig. 154, is designated as the distorting component of the armature current, since, as it reaches its maximum value when the centre of the armature coil is midway between the pole-tips, the ampere-turns due to it are then in the most effective position for setting up a cross-magnetizing action in the air-gap.

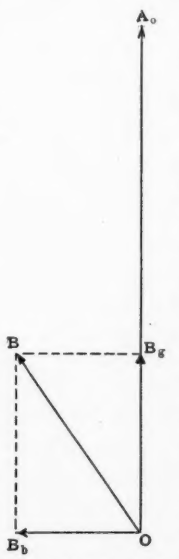


FIG. 154.—ALTERNATING MECHANISMS.

Fig. 155 accordingly shows the position of the armature coils when the effective or distorting component of the current is a maximum. Similarly, the wattless component of the armature current, or that component, OB_b, that is at right angles to the total internal electro-motive force OA_0, is designated the magnetizing

component of the armature current for the reason that when this component reaches its maximum value the centre of the armature coil is concentric with the centre of the pole-piece; the ampere-turns, due to the magnetizing component of the armature current, are accordingly most powerful when the armature coils have the position shown in Fig. 156.

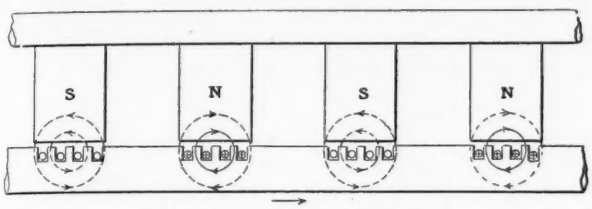


FIG. 155.—ALTERNATING MECHANISMS.

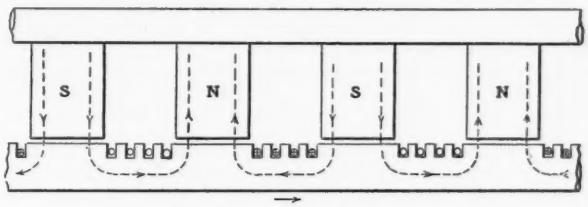


FIG. 156.—ALTERNATING MECHANISMS.

Continuing this line of argument, since when the centre of an armature coil is under the centre of the pole-face the distorting component is zero, as the coil revolves the component rises and reacts magnetically against the field. However, this reaction becomes equal to zero as the coil passes a position ninety degrees from the first; but it is prominent again, and, in this case, aids the field between the ninety-degree and 180-degree positions. At the latter of these the distorting component is zero again.

The effect of the distorting component upon the field ampere-turns is, then, as follows: It makes one complete oscillation, first opposing and then aiding the magnetizing effect of the field ampere-turns. The two magnetizing actions of the distorting component are equal and opposite and do not change the average value of the magnetism in the field cores from its initial value. The distorting component tends simply to shift the air-gap flux in the direction of the rotation of the armature in much the same way as in a direct-current machine.

In Fig. 157 the curve *a* indicates the normal no-load distribution of flux in the air-gap. When the centre of the coil is at the two points O_1 and O_3 (as in Fig. 155), it has its greatest cross-magnetizing effect and produces a distortion represented by the curve *b*. When the centre of the coil, however, is at O_2 (as in Fig. 156) the cross-magnetizing effect of the coil is zero, but, owing to the sluggishness of the magnetism, the distribution of the flux in the air-gap does not change materially from the distribution indicated by the curve *b*. It probably assumes a distribution such as that represented by the curve *c*.

The magnetizing component of the armature current reaches a maximum when the centre of the armature coil coincides with the centre of the pole-face, as in Fig. 156. At points ninety degrees on each side of this position the magnetizing or wattless component of the current is zero. The reactive effect of the magnetizing component is always against the field ampere-turns when the armature current OB lags behind the total internal electro-motive force OA_0, and always aids the field ampere-turns when the armature current is in advance of the total internal electro-motive force.

In Fig. 158 the curve *d* represents the

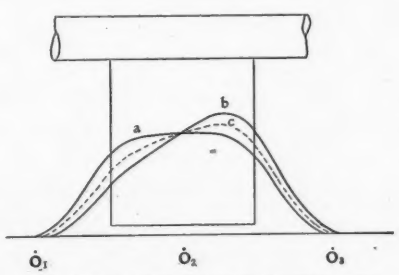


FIG. 157.—ALTERNATING MECHANISMS.

magnetizing component of the armature current, the curve *e* the magnetizing effect upon the field circuit of a direct current when such a direct current is sent through the armature coils of the alternator, and the armature is turned so as to successively advance the coils in their positions relatively to the poles.

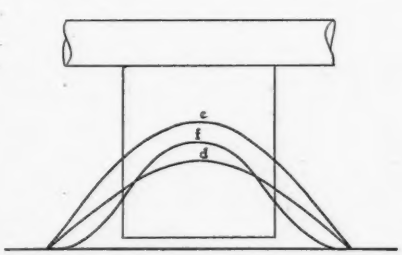


FIG. 158.—ALTERNATING MECHANISMS.

In the present discussion, the curve *e* is assumed to be a sine curve, and its values are plotted relatively to the centre of an armature coil in its successive positions, as are also the values of the magnetizing or wattless component of the alternating-armature current *d*. The product of the corresponding ordinates of the curves *d* and *e* give the curve *f*, which represents the magnetizing effect of the ampere-turns due to the magnetizing component of the armature current for successive positions of the armature coils relatively to the poles.

The resultant curve *f* of Fig. 158 would lead us to infer that the armature reaction of an alternator sets up a pulsating magnetism around through the magnetic circuit and the field coils. This is, however, not altogether the case. Owing to the fact that saturation does not usually exist in the magnetic material of the field circuit and to the large number of turns in the field winding, the inductance of the field circuit is very high and, therefore, any change in the number of lines of force threading the field coils will induce a powerful counter-electro-motive force in these coils which will, for the time of the variation, act with or against the direct electro-motive force to which the exciting current flowing in the field circuit is due. Any fluctuation in the field magnetism, therefore, tends to induce a current in the exciting circuit which will oppose any change in the amount of flux linked with it and act magnetically to keep the field strength a constant. Now if, in considering the reaction of the armature of an alternator upon the field circuit of the machine, we regard the armature as nothing more than the primary of a transformer, of which the field windings form the secondary, magnetic fluctuations emanating from the armature and effecting the field circuit will induce in the exciting circuit an alternating current tending to magnetically balance the cyclic fluctuations of the armature reactions. If, therefore, air-gap leakage, etc., may be neglected, the magnetic density in the field cores will be practically constant for any given load upon the alternator, *i. e.*, it will not be subject to any great variation within the time for a periodic fluctuation of the armature current, and the exciting current will be a pulsating, continuous current having a fluctuation double that of the armature current.

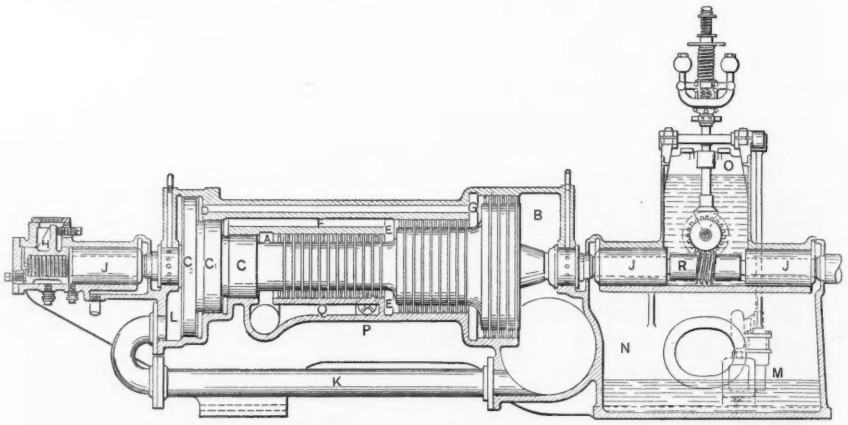
(To be continued.)

The Steam Turbine Generator of the Hartford Electric Light Company.

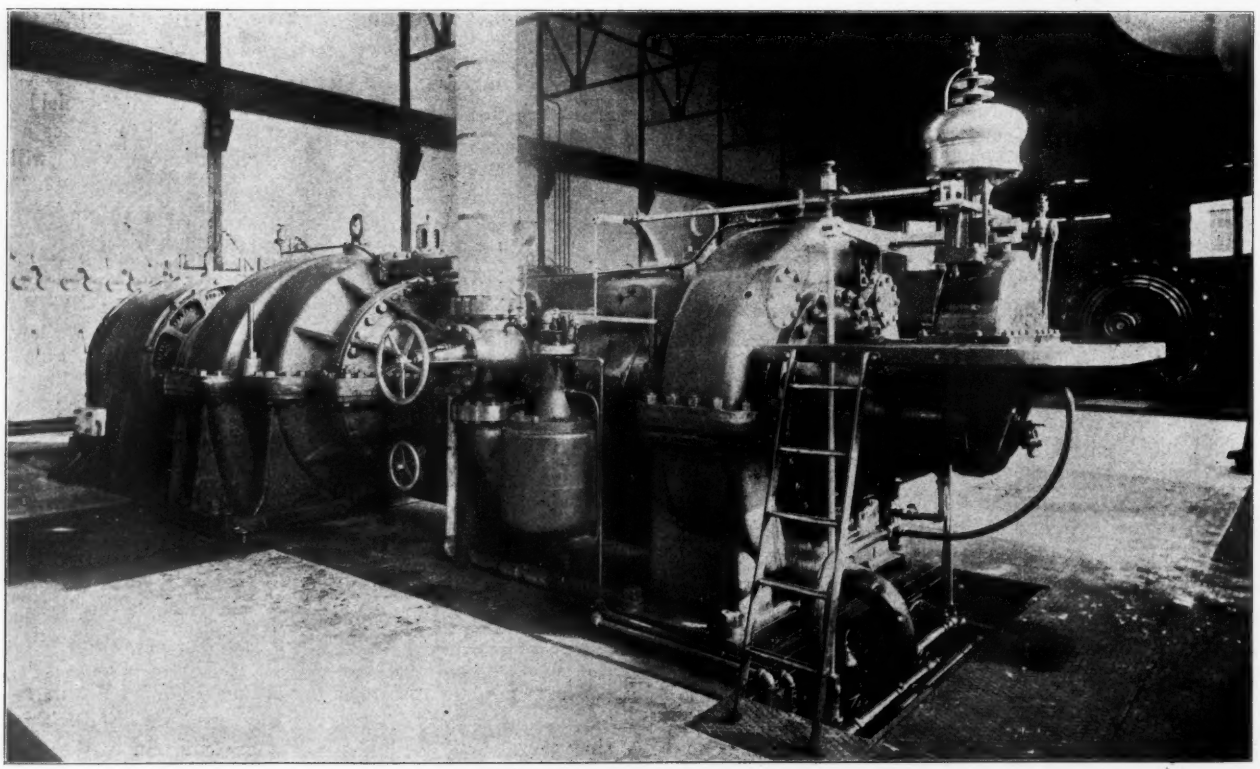
The Largest Turbine Generating Apparatus in the United States.

AT THE station of the Hartford Electric Light Company, in Hartford, Ct., there is now installed and in operation a reserve unit consisting of a steam turbine of about 2,100 kilowatts capacity direct-coupled with a two-phase 2,400-volt generator, this unit being intended primarily to aid the water-power plant of the company at times of excessive load and at certain periods in the summer when the water power falls off through low water.

The plant of the company consists, in brief, of two water-power generating stations located, respectively, at Tarriffville and Rainbow, two points on the Farmington River, each about eleven miles from the main receiving and steam generating station, which is situated in Pearl street in the city of Hartford. At each of these plants two-phase alternating current at 500 volts and sixty cycles is generated, this being stepped up to 10,000 volts and whence they are taken underground about one mile to the main or Pearl street station. Here they are received in a step-down transformer room where the pressure of the incoming current is reduced to 2,400 volts, which is the standard for alternating-current distribution. A considerable portion of the current here received is transmitted at this lower voltage to the State street station about 1,500 feet away, wherein is situated the large storage battery fed through rotary converters, and which may be regarded as the centre of distribution for the direct-current feeder system of the city.



SECTIONAL VIEW SHOWING DETAILS OF A STEAM TURBINE.



THE 2,100-KILOWATT STEAM TURBINE GENERATING UNIT OF THE HARTFORD ELECTRIC LIGHT COMPANY.

simultaneously changed to three-phase for transmission to the city. The lines come in overhead to the outskirts of the city,

At the State street station, in addi-

tion to this receiving plant, are located two 400-kilowatt rotary converters which feed into the three-wire direct-current system, and one 600-kilowatt and one 400-kilowatt alternating-current generators, steam driven by means of Corliss engines.

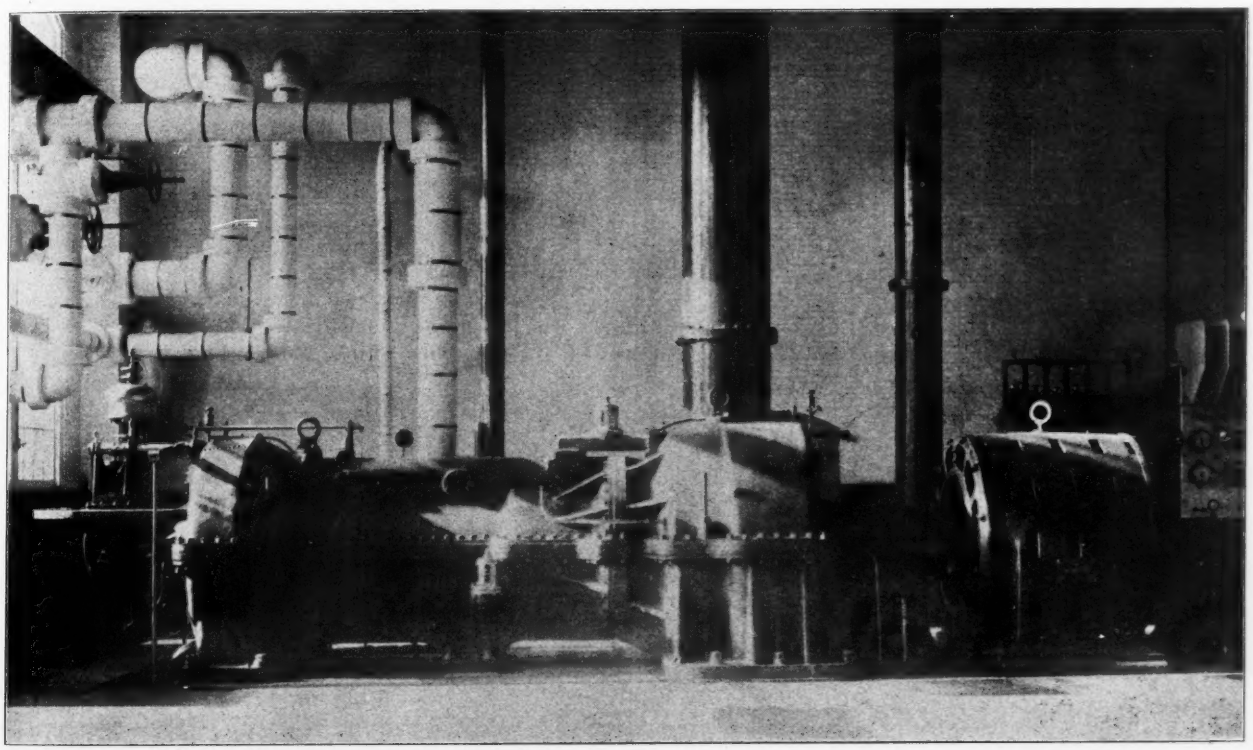
The steam plant is of unusual interest on account of some of the methods employed in its operation. Steam is generated in water-tube boilers of the Aultman & Taylor type, which are fired by Roney mechanical stokers, bituminous slack coal being used. All of the steam units are operated condensing, the condensing water being used over and over again by means of a group of Worthington cooling towers, which are erected in the yard near the boiler room. These towers consist of circular steel stacks, at the bottom of each of which is an electric motor-driven fan; this fan circulates air up through the stacks, which are filled with hollow, porous, unglazed tiles over which the hot water from the condensers is allowed to trickle, cooling itself by its own evaporation. An artesian well on the company's premises supplies the necessary feed and condensation water, although the city water supply is also connected.

From this station are fed about 1,000 arc lamps and 80,000 incandescent lamps.

The steam turbine unit, which is excellently illustrated in the accompanying engravings, is of the Westinghouse-Parsons type. The general type of this turbine can be well understood from reference to the accompanying sectional illustration. Steam is admitted at the governor valve and arrives at the chamber, A, at the small end of the revolving part of the turbine. The steam passes along to the right through the turbine blades, passing through a series of fixed blades which deflect it in one direction, thence striking the moving blades of the turbine which deflect it in the opposite direction, and so on. In this way the current of steam impinging upon the moving blades drives them around. The areas of the passages increase, progressing in volume corresponding with the expansion of the steam. On the left of the steam inlet are revolving balance pistons, CCC, one corresponding to each of the cylinders in the turbine (which may be of any number). The entering steam at A presses equally against the revolving part of the turbine and against the first balancing piston. When it arrives at the passage, E, it presses against the next larger section of the revolving part of the turbine and also against the next largest balancing piston, connection between the two being secured by the passage, F. Similarly, the passage, G, permits the balancing of the largest section of the turbine. By a proper arrangement of these balancing pistons there is no end-thrust whatever upon the turbine shaft at any load or steam pressure. The thrust bearing at H, on the extreme left, is put in to take care of accidental thrusts that may arise and also to retain the alignment of the shaft accurately so as to secure the correct adjustment of the balance pistons.

Since these balance pistons never come in mechanical contact with the cylinder in which they turn there is no friction. The thrust bearing is made of ample size and is subject to forced lubrication.

The pipe, K, shown at the lower part of the machine connects the chamber back of the balance pistons with the exhaust outlet, so as to ensure the pressure being equal at the two ends of the turbine.



SIDE VIEW OF THE HARTFORD STEAM TURBINE GENERATING UNIT SHOWING STEAM AND EXHAUST PIPING.

The bearings, JJ, are peculiar in construction. Each consists of a gun-metal sleeve, prevented from turning by a loose-fitting dowel pin. Outside of this are three cylindrical tubes having a small clearance between them. These small clearances fill up with oil and permit a slight vibration of the inner shell, while at the same time restraining it from too great a movement. The shaft therefore actually revolves about its axis of gravity instead of its geometrical axis, as would be the case with the bearings of the usual rigid construction. In case the shaft is a little out of balance the journal thus permits it to run slightly eccentric.

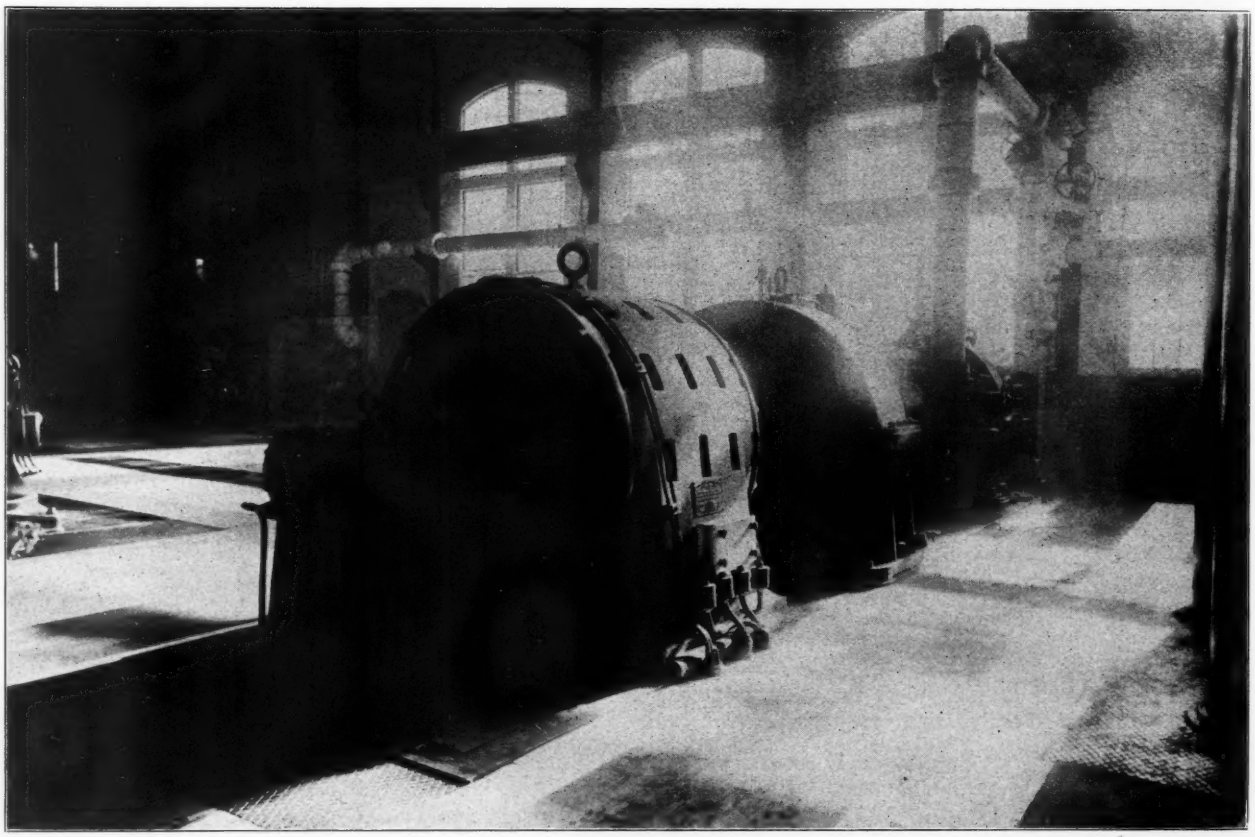
The governor is driven, in the machine shown in the sectional drawing, by a worm

gear cut on the outside of the coupling between the turbine shaft and the machinery it drives. In the machine at Hartford, however, the governor is operated from a worm gear on the end of the shaft, as the illustrations well show. The oil pumps are also operated by the same gear, these pumps serving to maintain forced lubrication throughout the machine. In the Hartford installation the oil is pumped first to an overhead receiver, where it is cooled by circulation of water and from which it flows by gravity into the various parts of the turbine.

The governor is one of the most interesting features of this machine. It is of the fly-ball type, the lever swinging on knife edges instead of pins. At the middle position of the levers full head of steam is admitted. A movement from this position in either direction cuts off the steam supply. In case any of the governor mechanism becomes broken and the balls slow down independently of the turbine, steam is shut off by this construction before any damage can take place. The speed of the turbine may be varied within the limits of the governor spring while the machine is running. This is done by means of a milled head on the governor which permits the adjustment of the spring without disturbing the running of the machine in any way. This adjustment is very useful in bringing the dynamo connected with the turbine into proper synchronism and in adjusting conditions of load between various machines running in multiple.

The governor levers are attached to a small relay valve which controls a steam valve and piston directly connected with the main admission valve. These levers receive reciprocating motions from an eccentric and use the governor clutch as a fulcrum. Continuous reciprocating motion is thus given to the relay valve and through it transmitted to the admission valve. The function of the governor is to vary the plane of oscillation of the relay valve, causing the admission valve to be opened for a longer or shorter period during each traverse. The steam consequently is admitted to the turbine in longer and shorter puffs which occur at constant intervals of time. At full load these puffs verge into practically a continuous blast, while at intermediate loads the puffs are shorter and further separated. By this arrangement the economy obtained from the use of high-pressure steam is secured at all loads. As the admission valve is constantly in motion it has no opportunity to get stuck, as might be the case where it moved only occasionally.

The blades and buckets of the turbine vary considerably in size from one end of the rotating part to the other, so that the size of the passages is constantly increasing, corresponding with the increasing volume of the expanding steam. The blades are made of steel of high elastic limit and are secured to the rotating part by caulking. The smaller blades have one-eighth inch clearance sideways and the larger blades about one-half inch, these dimensions being much beyond the limits of motion permitted by the balance piston.



THE GENERATOR END OF THE HARTFORD STEAM TURBINE UNIT.

The Hartford turbine with its generator is in all thirty-three feet three inches long, eight feet nine inches wide, and weighs 175,000 pounds. It operates at 1,200 revolutions per minute under 125 pounds initial pressure and a vacuum of twenty-seven inches. The generator produces sixty-cycle current at 2,400 volts two-phase. Since the installation of the machine a number of tests have been made of it, including some continuous overloads. The figures attained are not as yet available for publication, but it may be said that they show a steam economy of the

most remarkable character, and that the apparatus shows an efficiency so high as to leave no doubt in the minds of those who are operating it that it represents the coming type of steam prime-mover for central station purposes. The efficiency varies considerably between different degrees of load, as is naturally to be expected.

This machine may be regarded in some degree as an experimental piece of apparatus, on account of its being the first turbine of this large size to be made and set running in this country under the somewhat modified Parsons designs. The experience that has been gained with it at Hartford has been exceedingly valuable and highly encouraging. It is readily started, warming up in a few minutes, and its operation is singularly quiet and free from vibration when the great speed at which it runs is considered. It is a curious contrast to note the small size of this unit in comparison with others in the station and to reflect that, at a pinch, it could carry the entire lighting load of the city without difficulty.

LORD KELVIN'S RECENT VISIT TO NEW YORK.

VISIT TO THE CORTLANDT STREET TELEPHONE CENTRAL OFFICE.

In respect to multifarious engagements and an overwhelming number of invitations, the visit of Lord and Lady Kelvin has resembled that of Prince Henry, who has so recently quitted our shores. Notwithstanding the disparity in years, Lord Kelvin has quite equaled the record of the Prussian prince. Among the various visits which have been made by Lord and Lady Kelvin, that to the Cortlandt street office of the New York Telephone Company is worthy of particular mention. On Thursday, May 8, Lord and Lady Kelvin were escorted from the Waldorf, their stopping place at New York, to the telephone headquarters by President Charles F. Cutler, of the New York Telephone Company, and Mr. J. J. Carty, chief engineer of that company. Gathered at the telephone office to greet the distinguished visitors was a notable assembly of telephone and telegraph officials. Among them were President Robert C. Clowry, of the Western Union Telegraph Company, attended by several of his directors; President F. P. Fish, of the American Telephone and Telegraph Company, who renewed the pleasant acquaintance which he formed with Lord Kelvin many years ago; Mr. E. J. Hall, vice-president of the American Telephone and Telegraph Company; President Charles F. Cutler and General Manager U. N. Bethell, of the New York Telephone Company; Vice-President Sargent and General Manager J. C. Reilly, of the New York & New Jersey Telephone Company.

The distinguished visitors were escorted through the Cortlandt street office and were greatly pleased with the fine installation of telephone central exchange apparatus there exhibited. Lady Kelvin displayed an appreciative interest in all that she saw and was particularly gracious in her appreciation of the arrangements made for the comfort of the operators there employed. In regard to Lord Kelvin, nothing probably could better indicate his continued active habit of mind than the ability which he displayed in examining and considering the large number of details going to make up such a plant as that at Cortlandt street. One incident which occurred during the visit is worthy of note. His attention having been called to the special fuseboard containing the connections between the cord circuits and the storage battery, after scrutinizing the apparatus, he remarked that one of the fuse wires seemed to be of larger diameter than the remainder, all of the wires being of very small calibre. Enquiry having been immediately made of the man in charge, it was found that this particular fuse wire had been installed by mistake. This little incident goes to show the continued keen power of accurate observation which has always characterized the scientific work of this eminent master of physics, and one of the engineers was heard to say that the interest displayed by Lord Kelvin in those details, which were brought to his attention, could not have been greater if he were a young engineer starting out on his career gathering data to be used in his work.

While ordinary visitors to the telephone exchange are content to view the installation superficially and as a spectacle, Lord Kelvin's examination was characterized by most searching questions as to the essential details of construction. Having shown a special interest in the development of Dr. Pupin's invention, several of the Pupin coils were produced for his inspection and to them he gave minute scrutiny. From the office of President Cutler connection was established with Chicago over the line equipped with the Pupin coils. At the Chicago end General Meaney conversed with Lord and Lady Kelvin. The success of the conversation was somewhat marred by the prevalence of a violent hurricane in Indiana which for the moment deranged the talking circuit. Notwithstanding this, there was a pleasant exchange of compliments, and Lord Kelvin expressed himself as being greatly pleased with having the opportunity to have talked over a line practically equipped with the loading device which has been the subject of so much interest in the scientific world.

MR. A. N. BRADY'S DINNER TO LORD AND LADY KELVIN.

Prior to their departure for England a complimentary dinner was tendered to Lord and Lady Kelvin at Delmonico's by Mr. Anthony N. Brady and his associates in the New York Edison Company. There were present at the dinner a number of gentlemen representing American electrical interests. Many ladies were also present. There were no formal toasts or speeches. On behalf of the electrical industries represented, Mr. Thomas Commerford Martin spoke at some length and very eloquently in welcoming the guests of the evening, briefly reviewing the advance made in the adaptations of electrical engineering in the United States since the first visit of Lord Kelvin, and referring to the great part that had been played in this advance by the work done in various lines of electrical and scientific activity by Lord Kelvin and his students.

In response, Lord Kelvin made an address characterized by deep feeling and great learning. It was evident that the distinguished guest had appreciated very deeply the continuous and extraordinary expressions of admiration and respect which have attended his recent progress through this country, and his remarks, both retrospective and prospective, were characterized by that comprehensive grasp of mind which is so prominently characteristic of him. The theme of Lord Kelvin's remarks was the conquest of material difficulties by science and the utilization of nature's forces for the benefit of the human race. He dwelt at length upon the part that had been played in this work by electricians. Referring to the work of Mr. Edison, who sat at his right, he said that the Pearl street station, in New York, was the first installation on this planet from which electric light and power had been distributed for general commercial use. He referred to his visit during the afternoon to the great waterside station of the New York Edison Company and stated that he had there witnessed the generation of electricity as high-tension polyphase current after the plans devised by Mr. Tesla, and its distribution and conversion to what he characterized as the "old-fashioned Edison

current of 120 volts." "Indeed," said Lord Kelvin, "I do not see anywhere these modern three-phase plants without thinking of Mr. Tesla, nor do I see the transformation of this output into direct current without thinking of the old Pearl street station and the splendid pioneer work of Mr. Edison."

Turning to the subject of the Niagara Falls power plant and the transmission from it to Buffalo and elsewhere, he said that he felt convinced that whenever the interests of the human race demanded it, the whole four million horse-power of the cataract would be utilized and distributed over a radius of three hundred miles. "I will not at present," said he, "predict a greater radius than this." To those who complained that the utilization of all of Niagara's water would result in the drying up of the cataract, and the destruction of one of nature's most beautiful works, he would say that the spectacle of orderly activity presented by the turning turbines and dynamos, with their almost infinitely complex transformations and varied details, was more beautiful than the spectacle of the unharnessed water thundering wastefully over the cliff.

AN INTERVIEW WITH LORD KELVIN.

I saw Lord Kelvin at the Waldorf-Astoria Hotel the day before his departure for England and found him in a reminiscent mood. He was not visibly fatigued from his long journey and the series of receptions and other functions that have marked its course, notwithstanding which he expressed himself as being pleased with the idea of a week's rest on shipboard. "It is a big country, and there is much to see in it," he said. "Now, don't ask me what I have been most impressed with, because I have been impressed with everything, and I have seen so much that I would hardly know where to start telling about the various items."

I asked him if he had noted anything particularly new in electric light application, and he said he had been very deeply interested in what Mr. Peter Cooper-Hewitt had shown him. "The mercury vapor lamp," he said, "seems to me to be capable of commercial development. It is one of the most interesting things I ever saw, not only on account of its high efficiency and the great volume of light that comes from it, but also on account of the extremely interesting light it throws upon some phenomena of the connection between the ether and ordinary matter. The nature of conduction in thin vapors is not sufficiently well understood yet, and some phenomena that Mr. Cooper-Hewitt has noticed, at the juncture of the electrodes in his lamps and the vapors, I think are going to have important bearing upon theoretical considerations of the ether. As to the light of the lamp, of course something will have to be done to improve its color, but the color screens I have already seen seem to be a long step in that direction."

I asked him if he was still interesting himself in the questions of the larger physics, referring to the time when I was a pupil of his for a brief season and to his lectures at the Johns Hopkins University on molecular dynamics. Lord Kelvin laughed when he remembered the twenty-one faithful students who labored with the mathematical intricacies of those lectures and whom he named his "twenty-one coefficients." It appears that in the general equation for molecular motion there were twenty-one coefficients, and this number agreed with the number of his students. "Indeed I am," he said, "and very deeply interested still in the study of the physics of the molecule and of the ether. I have lately been doing some work which is shortly to be published in the *Philosophical Magazine* regarding this very matter. I think our conceptions of the ether are about to undergo a change. You know we have built up a pretty complicated structure already, because we have burdened the ether with demands that it shall explain the action of gravity, of electricity, of the transmission of light and other undulations, and now magnetism, which is, of course, a necessary sequence. As for me, though, I am beginning to agree with Daniel Bernouilli. You know he proclaimed himself to be more of a Newtonian than Newton—an *'echte Newtonianer'*—still he did not think it was necessary that the ether should play a part in the explanation of gravitation."

Speaking of the general conceptions of the physical universe, Lord Kelvin said that we would probably simplify our imaginings of the mechanism of space and matter; that at least the increasing complexity of conceptions of the ether would go no further. "We have endowed the ether with many mysterious and difficult properties already," he said, "for example, it must either be entirely insusceptible to the action of gravitation, otherwise it would condense itself in centres, or else it must have an infinite resistance to compression. It has already been found necessary to consider it almost infinitely rigid and at the same time almost infinitely tenuous. Just where these speculations will stop I do not know, but I think that the tendency of all discussion and thought now-a-days is to make more simple our conceptions of the ether and its actions."

Lord Kelvin said he had greatly enjoyed his visit in America, where he had seen many friends of former days and had noted with satisfaction as well as with amazement the increase in electrical engineering applications and the widespread use of electrical appliances. "But I have had to do twenty-nine hours' work in every twenty-four," he said with a smile. C. T. C.

American Institute of Electrical Engineers.

An extra meeting of the Institute will be held on Wednesday, May 28, at 8.15 P. M., at the house of the American Society of Civil Engineers, 220 West Fifty-seventh street, New York city, which will be devoted to the general subject of "Electricity in the Army and Navy." Members of other national engineering societies have been invited to attend, also members of the Society of Marine Engineers and Naval Architects. One of the principal objects of the meeting is to demonstrate the advantage of the government's calling upon the engineering societies for advice in its work, and for this reason officers of the army and navy and others especially interested in the subject are invited.

There will be papers by Captain John Stephen Sewell, chief of engineers, U. S. A.; Lieutenant W. Van N. Powelson, U. S. N.; Lieutenant Henry George, U. S. N.; Dr. Louis Bell, consulting engineer; Colonel Samuel Reber, U. S. Signal Corps; Lieutenant A. M. Beecher, U. S. N.; Mr. Caryl D. Haskins, Mr. W. M. McFarland (late U. S. N.), and others.

The offices and library of the Institute have been removed from 26 Cortlandt street to the seventh floor of the White Building, 95 Liberty street, one block directly south of the former location.

New Directors for New York Telephone Company.

At the annual meeting of the New York Telephone Company, held at the company's offices, 15 Dey street, New York, on Tuesday, May 6, 1902, the following directors were elected: Charles F. Cutler, Union N. Bethell, John H. Cahill, Thomas F. Clark, Robert C. Clowry, Joseph P. Davis, Frederick P. Fish, George J. Gould, Edward J. Hall, James Merrihew, Charles Steele, John B. Van Every and William H. Woolverton.

A St. Louis Wire and Rod Mill.

A steel wire and rod mill, to cost more than $1,000,000, will be built in East St. Louis by the John A. Roebling's Sons Company, of Trenton, N. J. A site has already been bought, but the location will be a secret until the plant shall be completed.

The System of the Cincinnati Gas and Electric Company.

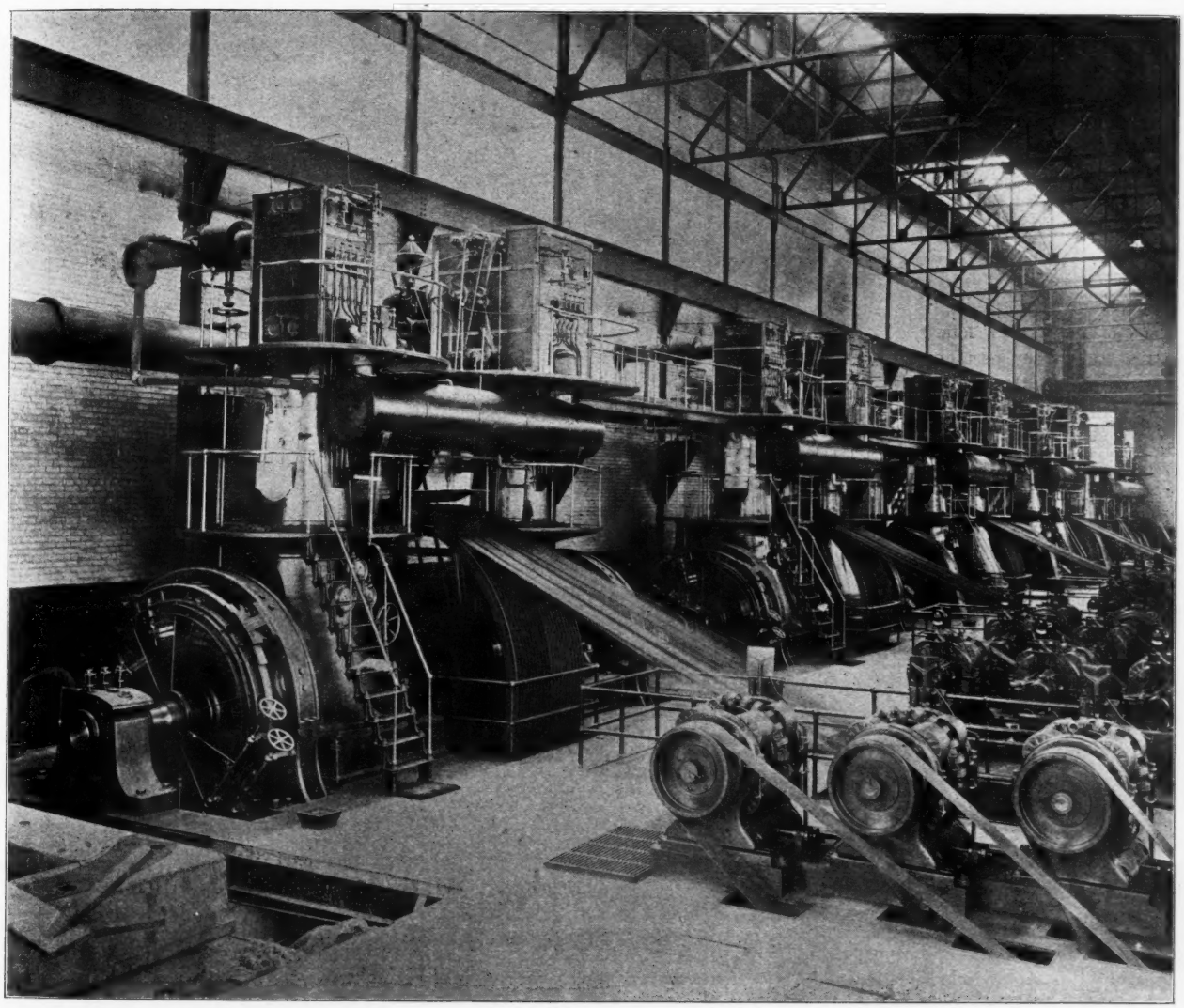
A Fine Modern Electric Lighting System Supplying Illumination and Motive Power to the Convention City.

By L. G. Lilley.

IN VIEWING the status of the electricity supply industry in Cincinnati to-day, the Cincinnati Gas and Electric Company may be complimented in the highest terms for the greatly improved condition now existing in its plant, also for the radical changes contemplated and in course of completion. Up to within the past year or two electric lighting and power were furnished from several central stations and the territory covered was limited to a comparatively small area. Even then the customer was still further confined to the use of the kind of current which he could secure, with the result that the use of electricity for power purposes was kept to a minimum.

The present condition is that all commercial lighting and power are furnished from three stations, two of which are not being run constantly, so that it can almost be said that one station is doing seventy-five per cent of the work in addition to furnishing current for the street lights.

This station, which is known as the Plum street station, was originally built by the Cincinnati Edison Company, with a ground area of 24,500 square feet and is located on almost the same site that the first commercial station in this city, put in by the Brush Electric Company, occupied. It is of fireproof construction, and when equipped, two years ago, contained the latest designed machinery in the market. Additions have been constantly made to this plant, until now the building is crowded with machinery, and contracts have been given for the addition of another building, which, when completed, will make it more than double its present size.



PLUM STREET STATION, CINCINNATI GAS AND ELECTRIC COMPANY, ENGINE SIDE.

The plant at present consists of the following machinery: Forty Brush series arc dynamos of one hundred 9.6 amperes

each, driven by rope transmission from a jack-shaft 200 feet long; six Allis-Chalmers vertical compound condensing engines, with an aggregate of 12,500 horse-power; boilers of Babcock & Wilcox and Edgemoor make (about equally divided), with an aggregate of 14,000 horse-power, all fitted with the American Stoker Company's under-feed stokers. All the coal and ashes are handled by the latest coal-handling devices.

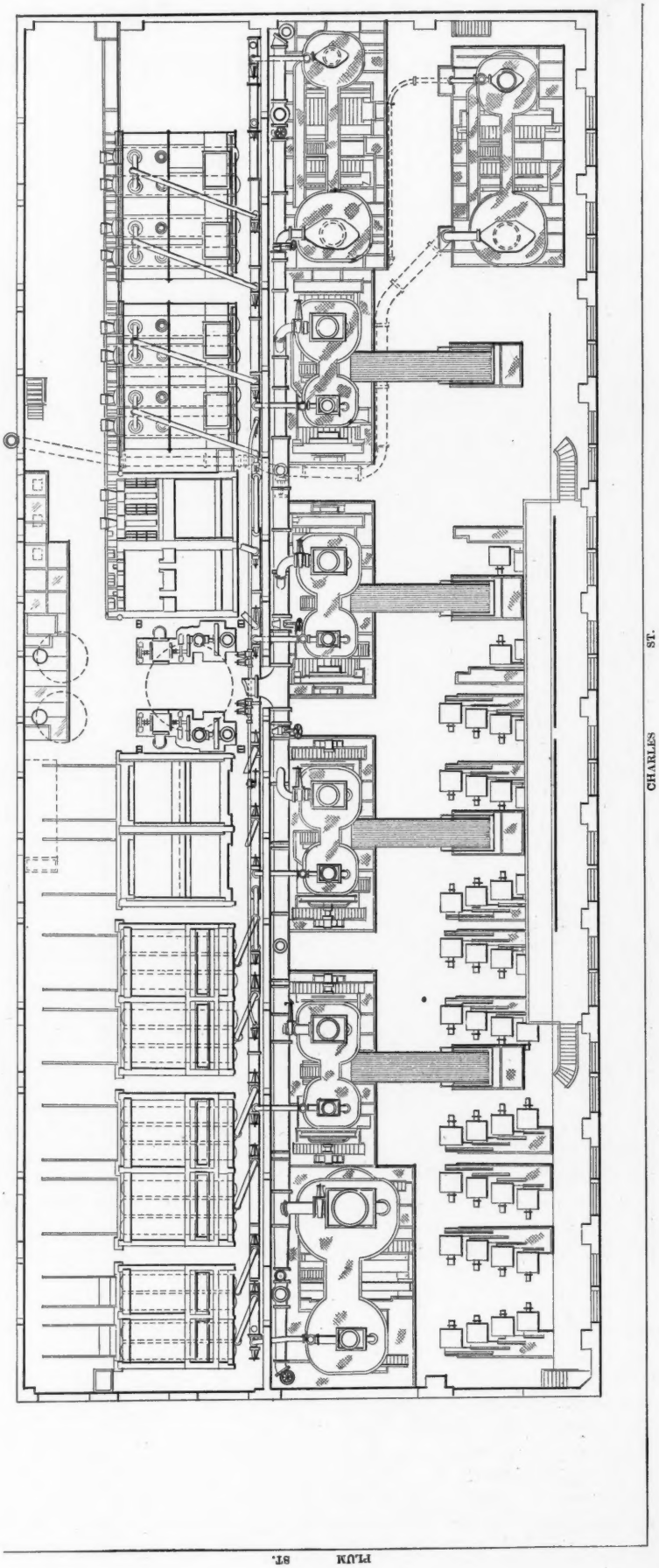
Direct-connected generators consisting of a total capacity of 5,200 kilowatts direct current, three-wire 220-volt and 2,000-kilowatt, three-phase, 4,500-volt machines.

In addition to this plant the company has a storage battery plant of 4,400 ampere-hours capacity, which is connected direct to the underground direct-current cable system, and "floats" on the system constantly, thus charging or discharging according to the weight of the load carried by the station. In the period of extreme peak of the load, the battery plant acts as an auxiliary to the station.

Probably the most important part of the proposed extensions—from a citizen's standpoint, at least—is the effort being made to remove all overhead wires, and to do away with aerial lines by placing everything underground in the business portion of the city. In order to do this the company has contracted for, and has under way, the opening up of upward of forty-three miles of the streets, and laying nearly 1,000,000 feet of American vitrified conduit, in which will be drawn lead-armored rubber-covered cables.

The present underground system which is in operation by the company consists of 32,260 feet of Edison three-wire conduit feeders, 115,280 feet of the same material for mains, and 316,777 feet of vitrified conduit, in which is drawn low-tension lead-armored rubber-covered cables for the purpose of supplying the Edison conduits for commercial lighting.

The new system of conduit now being installed, while chiefly for the purpose of supplying the street lights, will also be used for commercial lines of 110 and 220 volts. The company has recently made a contract with the city for furnishing between 4,500 and 5,000 four-ampere, seventy-five-volt, enclosed series alternating arcs for a period of ten years, at the following rates: Arcs fed from the underground system in the business portion of the city for $72 per year; arcs on overhead circuits $60 per year. These lamps will be furnished by the General Incandescent Arc Light Company, of New York, and will be run sixty on a circuit,



GROUND PLAN OF THE PLUM STREET STATION OF THE CINCINNATI GAS AND ELECTRIC COMPANY.

with the No. 6 cable running directly into and from each lamp, without any intermediate break of insulation. All cables for the underground work will be furnished by the Safety Insulated Wire and Cable Company, of New York.

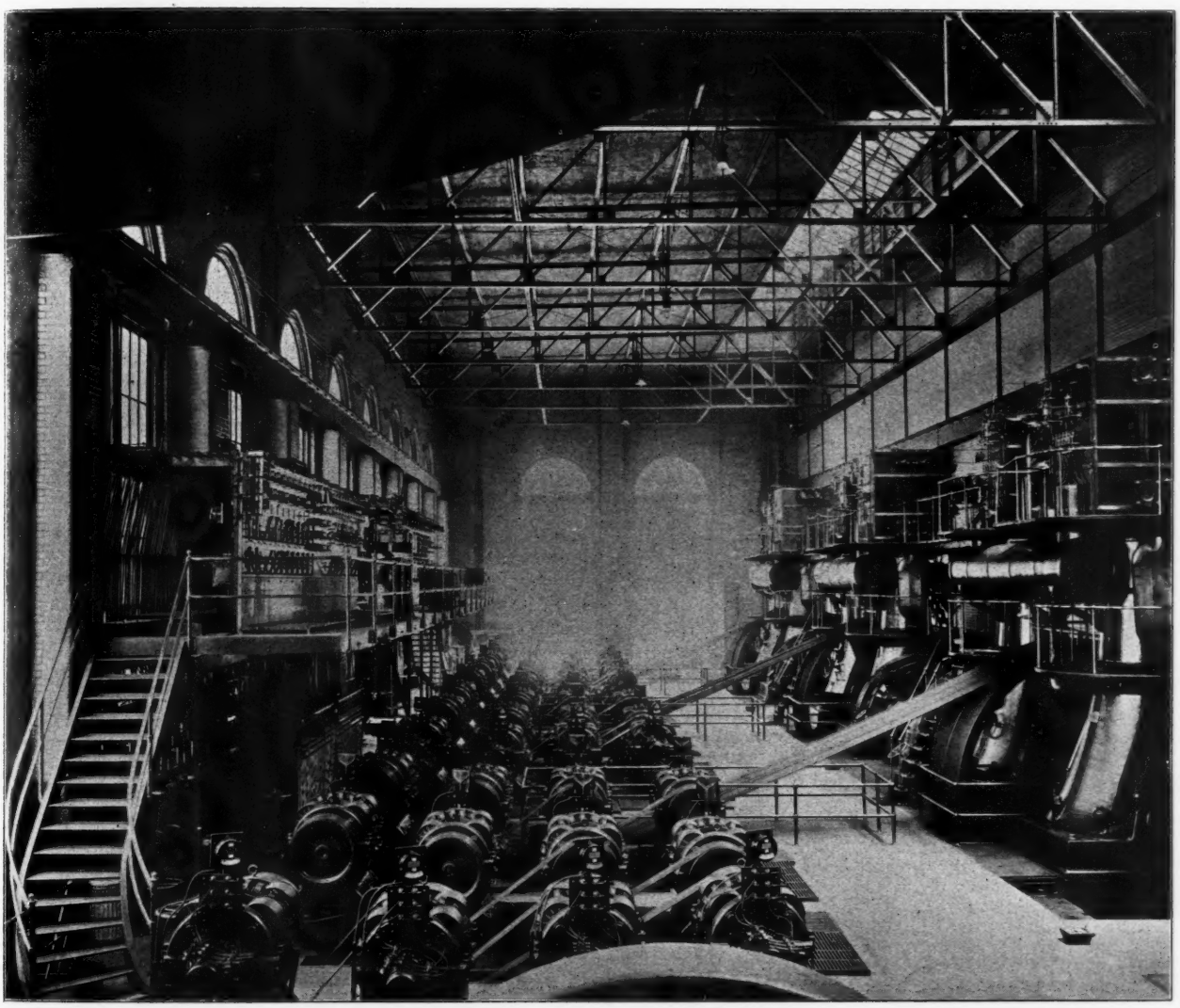
The station extension has been placed in the hands of Messrs. Sargent & Lundy, of Chicago, who will increase the capacity by installing Stirling boilers of 10,000 horse-power, and 8,000 horse-power additional engine capacity of Allis-Chalmers make, to be delivered by October, and four 450-kilowatt, 150-volt, direct current; one 2,500-kilowatt, 300-volt, direct current, and one 2,500-kilowatt, 4,500-volt, three-phase generators, to be delivered in July and August. Two motor-generator sets, of 1,000 kilowatts each, will also be installed, each set consisting of a 500-kilowatt, direct-current machine of 300 volts, and a 500-kilowatt, three-phase machine of 4,500 volts, and so arranged that the alternating-current generator of each set can be run as a synchronous motor for driving the 500-kilowatt direct-current machine, or *vice versa*. All of these machines are to be furnished by the Bullock Electric Manufacturing Company, of Cincinnati.

When the above additions are all in place the total capacity of this station will be 10,500 kilowatts of three-wire 220-volt direct current and 5,500 kilowatts of three-phase current at 4,500 volts.

There will also be three substations located at different points of the city for the purpose of keeping the voltage of the lines constant.

At the present time there is a conglomeration of service lines throughout the business part of the city as follows: 110 and 220-volt direct current, and 104 and 110 single-phase alternating current for commercial lighting; series arc circuits; 500-volt power lines. After the changes are made there will only be 110 and 220-volt direct current, and the three-phase, sixty-cycle alternating current for power through induction motors, enabling the abandonment of all 500-volt, series arc and single-phase, 125-cycle alternating-current lines.

The new alternating-current system will be of the three-phase, four-wire, sixty-cycle type, with 2,300 volts difference of potential between the neutral and outside legs, and 4,000 volts between any pair of the outside legs, reducing to secondary direct where the load is heavy enough. The three-wire system will be utilized by using two transformers to each block, but where the service is light only one transformer will be used in the usual manner. These lines will also be used for driving three-phase induction motors of any desired size, or for single-phase motors, up to one horse-power. The company is also supplying current to the Southern Ohio Trac-



PLUM STREET STATION, CINCINNATI GAS AND ELECTRIC COMPANY, SWITCHBOARD SIDE.

tion Company from its 4,000-volt line to a 200-kilowatt rotary converter, giving out 500-volt direct current for operating the street cars.

At the present time the company is furnishing 3,408 series arc lamps on 9.6-ampere circuits for public street lighting, which are taken care of by thirty-one trimmers. The entire city is patrolled each night by ten inspectors, whose duties also include the commercial lines as well as the street circuits. In addition to the above there are 4,500 enclosed arcs supplied from direct and alternating circuits, and 512 series arcs, which are taken care of by fourteen trimmers, who also act as inspectors in their respective territories.

The company has upward of 8,000 meters installed, 7,500 of which are Thomson recording wattmeters; the balance are the Schaeffer alternating type, and are used in the "Hilltop districts."

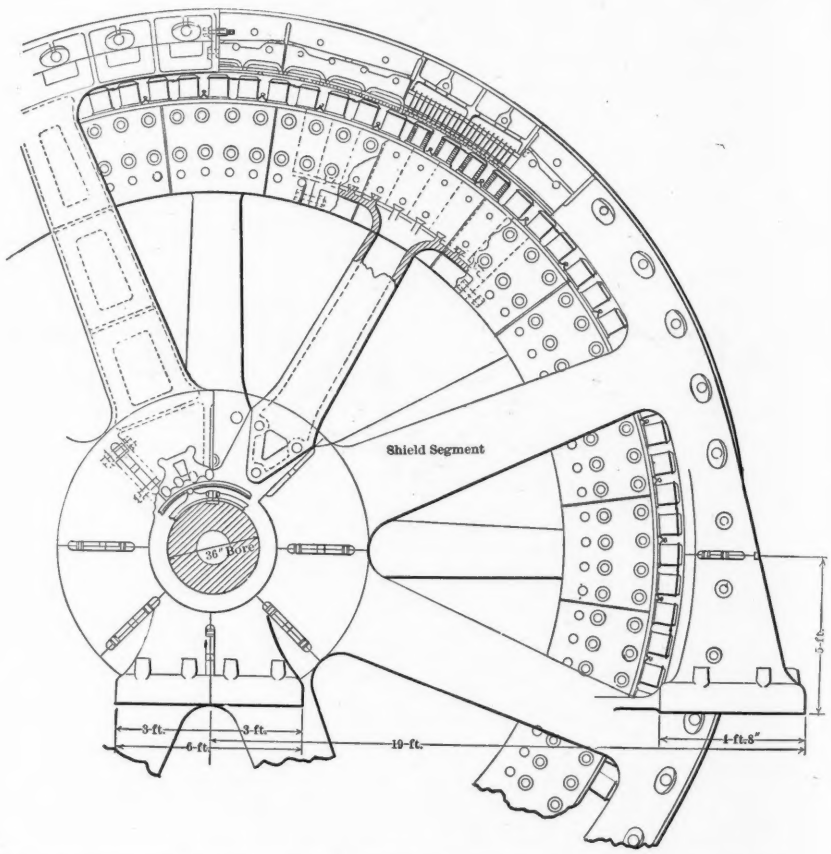
Before the consolidation of the Cincinnati Edison Company with the Cincinnati Gas Company there were five generating stations in constant use, and yet their area of business was practically confined to a comparatively small portion of the area of the city. Now since the consolidation two of the stations have been shut down entirely, and of the remaining two, one only runs a few hours each week to help out during the hours of heavy load. The time is within sight when these will go the way of the former ones, notwithstanding that the company has extended its lines over almost the entire corporate limits of the city, and is prepared to give service second to none in the country.

The company is exceedingly fortunate in having the following corps of officers: General A. Hickenlooper, president; Norman Kenan, vice-president; H. C. Hutchison, superintendent of electrical department; H. J. Pfiester, superintendent of electrical distribution; C. E. Jones, superintendent of stations.

DESCRIPTION OF ALTERNATING-CURRENT MACHINERY.

The alternator built by the Bullock Electric Manufacturing Company is designed for 2,500 kilowatts, normal load, and 3,120 kilowatts, continuous overload. It is a three-phase generator of 4,500 volts between terminals, and it operates at seventy-five revolutions per minute. The generator has ninety-six poles, and therefore produces alternating currents of sixty cycles.

The conditions of which this machine had to be designed are rather exceptional, as may be seen from the fact that this machine is the largest of its kind in this country. The generators in some of the New York traction companies' stations have a larger output, but they are designed for twenty-five cycles and have not more than forty poles, while the generator built for the Cincinnati Gas and Electric Company has ninety-six poles. It is apparent that the construction of a machine which requires the placing of so many poles on the circumference of a wheel offers problems to be solved by the engineers of a nature far more difficult than those that have to be solved for twenty-five-cycle generators which require only a moderate number of poles.



OUTLINE DIAGRAM OF ONE OF THE 2,500 KW. GENERATORS FOR THE CINCINNATI GAS AND ELECTRIC COMPANY.

The general construction of the alternator may best be studied from the drawings, showing an outline of the generator. The question that had to be solved at the outset was whether it would be advisable to build the machine as a flywheel generator, using the flywheel to carry the poles, or whether the generator should be built as a self-contained engine-type machine with a separate flywheel alongside of it. There are some advantages and some drawbacks in either construction. The flywheel-type generator requires a large diameter in order to be able to reduce the weight of the flywheel for a given moment of inertia, which necessitates a heavier construction for the large armature to obtain rigidity and stiffness. On the other hand, the engine-type generator, being of smaller diameter, requires the construction of a special rotor to carry the poles, and thus the advantages obtained by a smaller diameter of the generator might well be considered compensated for by the necessity of making two revolving parts and the greater space taken up by the combination.

Aside from the greater engineering difficulties connected with the building of generators of very large diameter and narrow core, there are several great advantages connected with a large machine in which the armature is narrow. As is apparent in looking at the drawing, the radiating surfaces of this machine are very large and therefore it is possible to design economical machines in which the temperature rise does not exceed thirty degrees centigrade at normal continuous load.

It will be interesting to give some of the dimensions of this gigantic machine. The outside diameter is thirty feet and the inside diameter is thirty-four feet.

The length of the pole, measured along the shaft, is eleven inches. It will also be instructive to study the weights of this machine, and we give, therefore, in the following, the general idea of the distribution of copper, steel and iron in this machine:

The total weight of laminated steel in the armature and poles is 42,000 pounds; the total amount of copper on the armature and on the fields is 13,100 pounds; the shields, the construction of which we will presently describe, weigh 128,400 pounds; the whole stationary part, including steel and armature copper, weighs 200,000 pounds; the revolving part, which is the flywheel of the steam engine, the weight of which will, of course, be determined by the inertia demanded by the engine builders, is 374,800 pounds, so that the total weight of machine is 574,800 pounds.

On account of the large size of the armature, it is built up between two shields, each of which was made in eight sections, as clearly shown by the drawings. The armature itself is made up in twenty-four sections, each of which can be removed. The winding is placed in open slots, there being two slots per pole and per phase.

The electrical guarantees of this machine will be of interest. The regulation at 100 per cent power-factor and full load will not exceed seven per cent. The efficiencies are as follows:

One and one-half load, ninety-six and one-half per cent; one and one-quarter load, ninety-six and one-half per cent; full load, ninety-six and one-quarter per cent; three-quarter load, ninety-five and one-half per cent; one-half load, ninety-four per cent; one-quarter load, ninety-one per cent.

The temperature rise at full load after twenty-four hours will not exceed thirty degrees centigrade; at twenty-five per cent overload after twenty-four hours it will not exceed forty degrees centigrade, and at fifty per cent overload after one and one-half hours it will not exceed fifty degrees centigrade. It is of interest to note the fact that this generator requires only twenty-four kilowatts for excitation at full load, in spite of the good regulation obtained.

DESCRIPTION OF MOTOR-GENERATOR SETS.

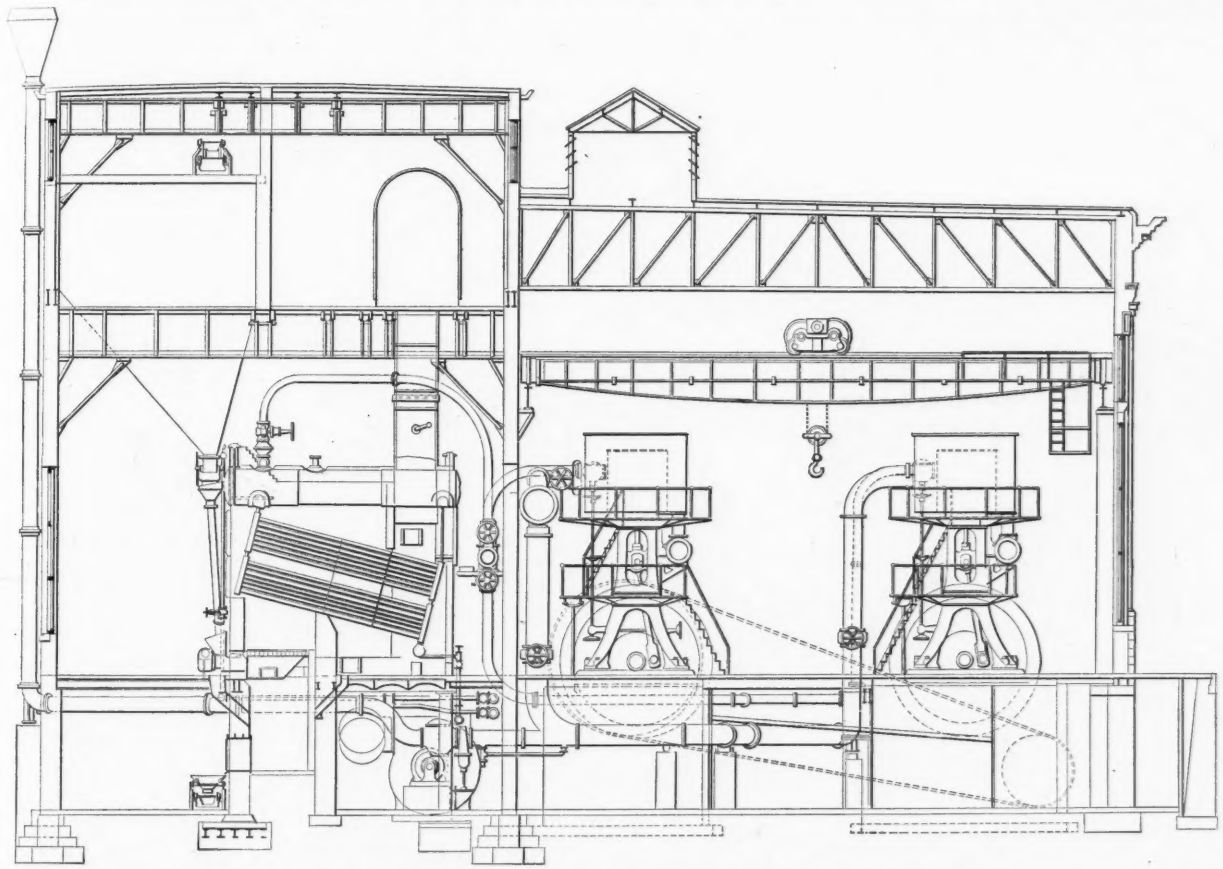
The synchronous motor is wound direct for 4,500 volts and operates at 450 revolutions per minute. It, therefore, has sixteen poles. There are several points of interest connected with its design. The revolving element consists of a steel wheel in which slots are milled to receive the dovetails of the laminated poles. These revolving fields are mechanically so well constructed that they can stand the enormous peripheral speed of two miles per minute or more.

The general construction of these synchronous motors is identical with the construction adopted by the manufacturers for their revolving field alternators.

DIRECT-CURRENT MACHINES.

The direct-current machines that are to be installed by the Cincinnati Gas and Electric Company comprise seven units, four being rated as 450-kilowatt, 150-volt, 250-revolution-per-minute, engine-type generators; two being rated as 500-kilowatt, 300-volt, 450-revolution-per-minute, which are to be driven by synchronous motors, and one rated as 2,500-kilowatt, 300-volt, 75-revolution-per-minute.

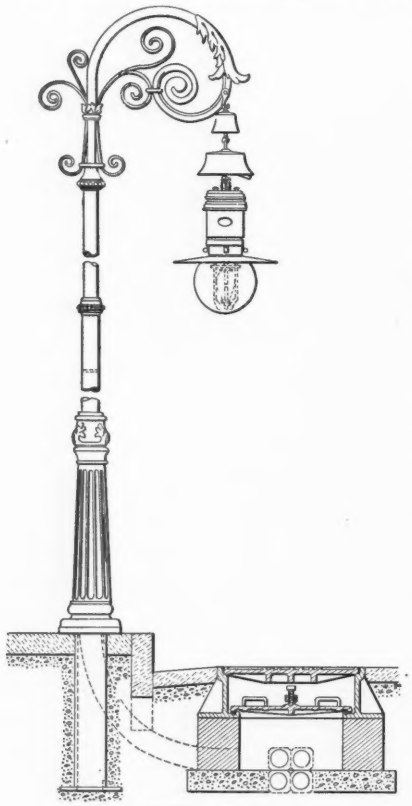
The main features of construction of the four 450-kilowatt engine-type generators are noted below. The field yoke consists of an annular cast-iron ring with inwardly projecting poles. The poles are built up of laminations of sheet steel in such a manner as to reduce to a minimum the effect of armature reaction. The poles



CROSS-SECTIONAL VIEW OF THE CINCINNATI EDISON ELECTRIC LIGHT COMPANY'S STATION.

are held in place by fillister head cap screws. By taking out these cap screws it is possible to slide the poles out parallel with the shaft without disturbing either the armature or the field yoke. The armature spider has its arms milled at the outer ends so as to fit into dovetailed notches in the armature segments. This method of construction for armatures built up of segments produces an armature in which the stresses due to centrifugal force are resisted by the strength of the armature steel, and the only stress put upon the cast-iron spider arms is of a crushing nature.

The armatures of these machines are



THE LIGHTING STANDARD.

well provided with ventilating ducts and, as the armature coils are held in the slots by means of wooden wedges, these ventilating ducts are not closed by any bands or wire around the outside. The commutator sleeve is cast in one with the front end-head of the armature, thus making the commutator an integral part of the armature.

In commutators, having diameters equal to or greater than those in the present machines, the front ring is cut into segments to facilitate handling.

The 2,500-kilowatt 300-volt engine-type generator has forty-eight poles with an external armature diameter of twenty feet. In construction, it does not differ materially from the 450-kilowatt generators described above. One feature shown in this drawing that is peculiar to the large engine-type generators of the Bullock company's manufacture is the device for oscillating the rocker arm carrying the brush-holders. By means of this addition, a motion of the brushes is obtained parallel to the shaft which is similar to the end play of the armature in a belted machine whereby the brushes are prevented from wearing grooves in the commutator.

While the nominal rating of this generator is 2,500 kilowatts it is guaranteed to carry continuously a twenty-five per cent overload, and is also guaranteed to have a full-load efficiency of ninety-five per cent.

A New Turbine Steamer.

A new turbine steamer, Queen Alexandra, built for passenger service on the River Clyde by William Denny & Brothers, of Dunbarton, and intended to work in conjunction with the King Edward, which was built by the same firm last year, has been launched recently from the above yard. The new vessel has a length of 270 feet, moulded breadth of 32 feet, and a depth to promenade deck of 18 feet 9 inches. The vessel is lighted throughout by electricity. The boiler is a large double-ended one having a funnel at each end, and there are three turbines, one high pressure and two of low pressure, the high-pressure one being in the centre line. Each drives one shaft, the centre one having one propeller and the outside ones two each, making five propellers in all.

An Electric Incline.

An electric incline, starting from the Piazza Principe, at Genoa, with a length measured on the horizontal of 3,520 feet and a difference of level of 615 feet, giving a mean grade of seventeen per cent, has been successfully installed. The rack and binding system is used, the rack being in the middle of a single track. The ties are supported on a strong masonry bed to prevent slipping. The cars are self-propelling and are arranged so that the platforms are horizontal when on the incline. The wheels are loose on the main axles, and each axle carries in the centre a large gear wheel which engages with the track, the gear being operated by a direct-current motor of thirty horse-power, working at 500 volts, which drives it by a set of reduction gears. The trolley system is used with the overhead wire supported on pole brackets. The car descends by its own weight, and in this case the motor acts as a brake by becoming a generator, a controller, by varying the resistance, regulating the descent at will.

Water Power in Turkey Awaits the Electrician.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I beg to acknowledge receipt of a copy of the ELECTRICAL REVIEW containing one of our recent reports.

Quite a number of our technical journals are regularly received in this office and continually brought to the attention of the large English-reading population of this district. The advertisements are studied with especial interest.

As the bulk of emigration from Asia Minor to the United States is from this district, I am glad to have prospective citizens become familiar with leading American periodicals.

Your heart would ache to see the vast amount of water power unutilized within a few miles in the great canyon of the Euphrates. Some day I hope it will supply motive power for an electric line passing over the mountains from the Mediterranean to the Black Sea.

At present the dynamo on my bicycle is the solitary representative in my district of American electrical work.

THOMAS H. NORTON,
United States Consul.

Harput, Turkey, April 14.

Coal-Handling Appliances Wanted in Laurenco Marquez.

During a recent conversation with Senhor Albers, the head of the harbor commission, writes Consul W. S. Hollis, he was informed that it is intended to make that port a great coaling station. It has been requested particularly that communication be invited with manufacturers in the United States who supply economical and up-to-date coal-handling appliances such as trestles, cranes and machinery for delivering coal from freight cars (three feet six inches gauge) into the holds and bunkers of vessels.

Alloys containing two parts of aluminum to one of zinc are, according to recent authority, equal to cast iron in strength. It melts at about 425 degrees centigrade, does not readily oxidize, and resists corrosion well. There is no difficulty in preparing alloy castings having a tensile strength of 4,000 pounds per square inch. The alloy, whose specific gravity is 3.8, resembles in its properties high-carbon steel. Alloys containing one to nine parts of zinc to one part of aluminum with specific gravities ranging from 4 to 6 do not appear to possess any particularly valuable mechanical properties.

An Electric Crane for Ship-Building.

The accompanying illustration gives an excellent view of one part of the ship-house or structural steel runway employed in the ship-building yards of the Fore River Ship and Engine Company, at Quincy, Mass. This structure is designed principally to afford a runway for traveling cranes which move backward and forward over the vessels under construction on the stocks below. The crane, of which one end is shown in the illustration, is 100 feet in clear span, with a lifting capacity of fifty tons. With this tool materials delivered on the railway tracks below may be lifted and put in position on any part of the ship-work going on, as is sufficiently evident from the illustration. The vessel shown in a nearly completed condition is a seven-masted steel schooner of 11,000 tons displacement, which will be one of the largest sailing vessels in the world. On the extreme right, under the centre of the crane, may be seen the beginning of work on the keel of the United States battleship Rhode Island.

The crane here illustrated was constructed by the Morgan Engineering Company, of Alliance, Ohio, the electric motor equipment having been furnished by the Bullock Electric and Manufacturing Company, of Cincinnati. Current is taken from trolley wires strung along the runways of the crane and all of the operations of traversing, lifting, etc., are conducted from the suspended cabin under the centre of the crane, giving the operative a clear view. Power is derived from the power-house of the yards, where the working current is generated and distributed to all parts of the large works. A complete description of these works appeared in the ELECTRICAL REVIEW for April 26, 1902.

STRUCTURE FOR RUNWAY OF LARGE ELECTRIC CRANE, FORE RIVER SHIPYARDS, QUINCY, MASS.

A Factory for the Electric Treatment of Peat.

Recently a factory has been built at Stangfjorden, in Norway, for the electric treatment of peat by the Jebsen process. According to a description given by the *Zeitschrift für Electrochemie*, the peat is first submitted to air drying and is pressed until the water contents are reduced to twenty per cent or under. It is then charged into retorts of special design, heated internally by electric resistance coils. A gas useful for heating purposes, and a tarry oil, distill over, while a very pure form of peat, charcoal or coke remains in the retorts. The tarry oil can be worked up for the recovery of paraffin, ammonium sulphate and methylalcohol. The electric plant at Stangfjorden consists of five 128-horse-power turbines and five dynamos of equivalent power. A daily treatment of 100 metric tons of air-dried peat is possible with this plant in the twelve retorts which are at present installed.

A Preservative and Lubricant for Wire Ropes.

A wire rope needs a lubricant that will penetrate all the wires, and, as a preservative, it must be free from acids and prevent rust. A good lubricant is made of tar, summer oil and mica axle grease in varying proportions to suit varying conditions.

Power Transmission on the Pacific Coast.

The Great Possibilities of High-Tension Development in the Extreme West.

By John S. Eastwood.

PERHAPS nowhere in the United States were the Lauffen-Frankfort experiments watched with greater interest than on the Pacific coast, for nowhere was fuel more scarce and expensive up to the recent development of the oil fields of California, and certainly nowhere in the world are the climatic and physical conditions more favorable to electrical power transmission.

The great backbone of the western hemisphere, the Cordilleras, stretching from the straits of Magellan on the south to the mighty Yukon on the north, running the entire distance near the Pacific coast, furnishes in the streams that drain its western slopes ideal hydraulic conditions for water-power development.

By reason of their proximity to the Pacific Ocean, the annual precipitation of moisture is great, much of it falling on the higher sources of the streams being perennial snows, which melt gradually during the long, dry seasons, thus furnishing a continuous flow, and the streams, running as they do to tide water with steep gradients, furnish abundant and ideal situations for high-head water-power development.

The people of the coast became early familiar with the handling of water under high pressure through their experiences with monitors used in hydraulic gold mining, and the use of impact or hurdy-gurdy water-wheels came to supply an incidental demand for a small amount of power for use about the mines.

From these humble beginnings has been evolved one of the most complete and unique systems of apparatus for the utilization of high-head water power in the world.

These high-pressure hydraulic installations are full of interest, and to do them justice as an engineering feature would require an article by themselves.

From the beginning the advance has been rapid in all departments of electrical transmission engineering, so that at the present time this department has reached a high state of perfection among many engineers of the coast who have made this class of work a specialty.

The cities and towns being in most cases located far out in the level valleys and on the bays, and thus far removed from the sources of water power, made it a matter of necessity to use electrical transmission to supply them with power and light.

The pioneer transmission plant was that built in San Antonia Canyon, Southern California, where power was developed in what is now considered a small quantity, under about 350 foot-head, and was transmitted at 10,000 volts to Pomona and San Bernardino, a total distance of thirty miles, and may be said to have been the entering wedge in the power transmission business.

The Redlands transmission came next and was the beginning of what is now the extensive Edison Electric Company of Southern California.

The Folsom-Sacramento plant came in next and attracted wide attention, not so much by the distance of transmission as by the size of the plant and the magnitude of its hydraulic works. In this plant 4,000 horse-power was transmitted twenty-two miles at 10,000 volts.

The next in order, which shows the bold strides in advance, was the San Joaquin Electric Company's plant, in which a head or fall of 1,400 feet was adopted, an increase of nearly 1,000 feet over any then built, and power was carried at 10,000 volts to Fresno, a distance of thirty-five miles. This plant held the world record for a long time in distance of transmission and is still in use of the highest head of any plant now in operation.

In 1898 the line voltage of this plant was raised to 19,500 volts and the lines extended to Hanford, Cal., making a total distance of sixty-nine miles, which again was for a long time the longest in the world.

After this followed in rapid succession a number of plants, in many of which improvements in arrangement and design were made, taking up the best features of preceding plants until many of them have been made models of constructive design.

Each plant has some distinctive feature or show point, which is the results of design or the surrounding conditions, and this variety is a source of surprise and delight to visitors; as, for instance, the Folsom-Sacramento plant has one of the finest stone dams in the world; the San Joaquin-Fresno plant has its high fall and beautiful granite power-house; the Santa Anna-Los Angeles plant (part of the Edison Electric Company's system) has its perfected generating units and magnificent pole line; the Snoqualmie Falls-Seattle plant its unique underground power-house; the Kern River-Bakersfield its perfect water conduit—a cement-lined tunnel in solid granite; the Bay Counties system its great cable span across the Straits of Carquinez, the longest in the world; the Standard its great water storage and hydraulic equipment, and the Mill Creek No. 3, of the Edison company (now under construction), its high head of 1,860 feet, and so on to a greater or less degree among them all.

It was found early in the history of power transmission business that a ready-made market was an element essential to success, but the great increase in the radius of transmission has brought sites within reach that were considered beyond reach before. As the majority of the inland towns were small, the first plants were built on the most accessible sites and of such sizes as to supply the local demand, and they are now, in many cases, being enlarged and supplemented to meet the growth of these markets.

There are a great number of power sites made available in addition to those now utilized by reason of the great increase in the radius of profitable power transmission, which distance has been increased, in less than eight years, more than ten times, and the great improvement in hydraulic apparatus.

Naturally, the largest cities, being located on the coast, are the last to receive the benefits of cheap electrically transmitted water power, but they will be the gainers in that they will be supplied by more highly perfected works.

The size of the works being such an important factor in the cost of power, other things being equal, these longer transmission projects, of necessity being large, will be enabled to deliver power in these larger cities at a less cost than is now possible with the smaller plants, even with their short transmission lines.

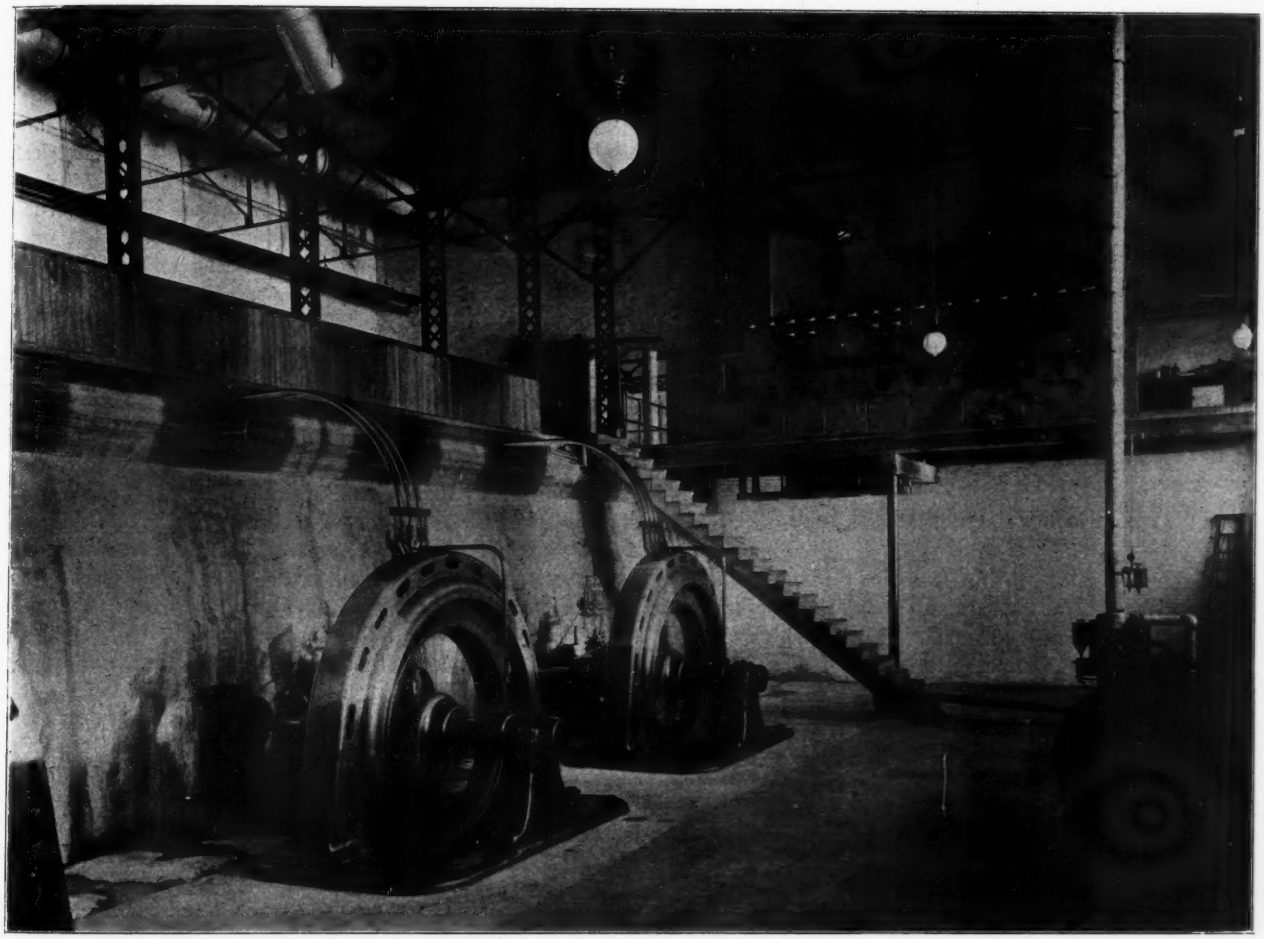
The possibilities of the electrical power transmission development on the coast are startling, there being a number of projects under investigation where it is proposed to develop from 10,000 to 250,000 horse-power at a single site for transmission to the largest coast cities.

It is a conservative statement of the situation to say that with the radius of successful transmission, raised as it is to 200 miles and over, there is more than a million horse-power that can be transmitted to the bay cities and San Francisco.

This statement is based on positive knowledge of the possibilities, and it is safe to say that nowhere in the United States is there such an abundance of power that can be cheaply developed as on the Pacific coast, and with the settling up of the country this coast will offer the most inviting field for manufacturers requiring cheap power for their development of any place in the union.

Electric Power in a Paper-Pulp Mill.

In no situation is the subdivision of applied power so particularly desirable as it is in paper-pulp mills. The machinery in such establishments has to run continuously and no regular period for repairs can be had. On this account the ability to shut down small sections of the plant independently is of great value in case of accident, and under normal conditions of running permits inspection and repairs to be made with the greatest ease.



THE GENERATOR ROOM, GREAT NORTHERN PAPER COMPANY, MADISON, ME.

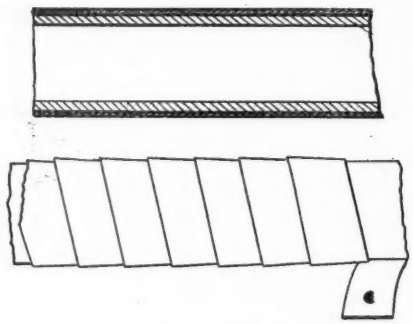
The accompanying illustration shows the generating room of the Madison mill of the Great Northern Paper Company, located at Madison, Me., on the Kennebec River. At this plant three 300-kilowatt generators, each running at 150 revolutions per minute and furnishing 600-volt three-phase current, are installed. Each generator is driven by a pair of thirty-three-inch horizontal shaft turbine wheels, each controlled by a Lombard governor. The exciter is steam-driven by a forty-five-horse-power vertical engine to which it is direct coupled. This apparatus is used also to light the plant in case of breakdown. Its service is required only at starting, normal exciting current being derived from a thirty-kilowatt direct-current machine driven by an induction motor from the main circuit of the large generators. The switchboard is of the usual type, and is built of blue Vermont marble panels. Oil switches are used, and all the power is fed into a single set of bus-bars. From these the various feeders for supplying lights and motors throughout the mill are taken off.

In the basement of the mill, wherein is situated the beaters, two 150-horse-power induction motors are set on concrete foundations, each motor being belted to a line shaft carrying three beater engines, one stuff pump, one rotary pump, one agitator and one Jordan engine. These motors are normally driven at overload when two beaters are at work. On the second floor in the screen-room one 200-horse-power motor is belted to a line shaft driving seven twelve-plate screens and two Jordan engines. In the wet machine room are located two ceiling motors, one of seventy-five and one of fifty-horse-power capacity, these being belted to shafts carrying four ground wood wet machines, eight Decker wet machines and two presses. The acid plant is operated by one 100-horse-power suspended floor motor belted to shafting which carries an average load of about eighty horse-power. Under the beater room is located one 100-horse-power motor running the rotary stock pump, boiler feed pump and the rotary screen, also a similar motor carrying one rotary pump with an average load of about seventy-five horse-power. Large exhaust fans over the machine room are driven by thirty-horse-power motors, and the carpenter shop is also motor-driven. The scraper of the economizer is similarly operated by a five-horse-power induction motor.

This plant was started November 1, 1899, with an approximate capacity of sixty tons of newspaper, forty tons of ground wood and fifty tons of sulphite pulp daily. It has been in continuously successful operation ever since. The entire electrical installation was put in by the General Electric Company, of Schenectady, N. Y.

Electrical Patents

A novel insulating covering has been devised and patented by Mr. Oliver T. Hungerford, of Brooklyn, N. Y. The object of the improvement is the covering (and in the case of an electric line conductor, the insulation) of a pipe, rod or electric line conductor by means of a certain compound, applying first a layer of the compound, then a layer of paper, and then another layer of compound over the paper covering. The paper with a coating of the compound adherent thereto upon one or both sides is also usable and valuable for many purposes. The compound itself is composed of pulverized silica, talc or kaolin—one, two or all three



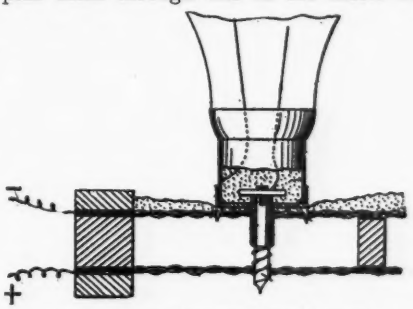
Covering for Pipes, Rods and Electric Line Conductors.

used at the same time—in intimate combination with rosin or asphaltum (preferably rosin) and rosin oil. This compound may be made by first melting the rosin in a suitable vessel, when it is melted adding the rosin oil and stirring the two well together, and then adding the pulverized silica, talc or kaolin, stirring this addition intimately and thoroughly as it is added until the required consistency is reached. This compound may be made non-inflammable to a practical degree by adding to the compound when it is hot a fluid oxide of zinc, oxide of lead, or alum in a powdered condition. The proportions, by weight, in 101 pounds, may well be 80 pounds of silica, 10 pounds of rosin, 10 pounds of rosin oil and 1 pound of oxide of zinc.

A new electrical metallurgical process has been devised or discovered by Mr. Edward G. Acheson, of Buffalo, N. Y. The invention relates to metallurgical processes, and more particularly those for the production of pure metals, carbides and other chemical compounds that are produced in an electric furnace in which carbon is used as a conducting, reducing or combining agent; and it has for its object to provide a process or method of cheaply and practically producing pure metals, alloys and other chemical compounds and products, and it may be said to consist, generally stated, in the use of graphite as a conducting, reducing or combining agent when associated with the metallic ore to be reduced to other substances or compounds to be operated upon. Efforts heretofore made for the practical direct production of pure products in an electric furnace—as, for example, metals like silicon—or for the production of pure compounds—as, for example, carbides of calcium—have proved failures, owing, among other things, to difficulty in effecting the reduction and also to the introduction into the finished product of impurities contained in the carbon used as a conducting, reducing or combining agent, or to carbon itself, resulting in the formation of impure products. The inventor has discovered that the above difficulties attending the reducing action in the electric furnace can be overcome and greatly improved results obtained by using as conducting, combining and reducing agent graphite, and preferably graphite which has been produced by the electric furnace. In this process there is utilized not only the purity and high electrical and thermal conductivity of graphite, but it has been discovered that its softness and divisibility give it a peculiar property of being brought to an extremely effective distribution with the ore or other substance to be operated upon. Its high electrical conductivity facilitates the passage of sufficient current to produce the desired reactions. Its high thermal conductivity facilitates the conduction of heat throughout the mass of ore or other substances with which it is mixed. It has been found that when an ore such as granulated silica and amorphous carbon in an amount sufficient for the reduction of such ore are mixed in the manner and to the extent ordinarily practised in making a mixture of these materials the mixture is practically non-conductive for currents as ordinarily used for metallurgical work, and even after a prolonged or thorough mixture its electrical conductivity is not sufficiently high for practical operation in the process of electrical reduction of the ore. When, however, graphite is substituted for the amorphous carbon, owing to its high conductivity, softness and divisibility, it can be so mixed with the ore or other material as to furnish the proper and desired degree of electric conductivity, and owing to the softness and divisibility of the graphite during the process of mixing it with the granulated ore the particles of ore become wholly or partially coated with the graphite, and good electrical conductivity is established throughout the mass with all the particles thereof by reason of this surface coating of the particles of the ore. In order to get this partial or complete coating of the particles of ore, it is necessary thoroughly to mix the particles of ore and graphite, and this is preferably accomplished by a tumbling or rubbing process, and the increase of conductivity and successful resultant-reducing operation depend largely upon the thoroughness with which the graphite is coated or spread upon the surface of the particles of ore. Thus, even when the particles of ore are mixed with graphite in the manner and to the extent ordinarily practised in making a mixture it has been found that the electrical resistance is excessively high, so as to practically inhibit the use of the electric current in reducing the ore, but on continuing the mixing and rubbing process so that the particles of ore become partially or wholly coated with the graphite, the electrical resistance of the mass is reduced until its conductivity is so far increased as to permit of the successful operation of the reduction with electric currents as ordinarily used in electro-metallurgical processes. For the application of the invention the ore and graphite are reduced to particles, preferably to small particles or powder, placing the desired amount of each in a suitable tumbling barrel or mixer and mixing the same, thus to a greater or less extent coating or varnishing the ore particles with the soft graphite. The mixture of the ore and graphite is then introduced into an electric furnace, where it is subjected to a temperature sufficient to cause the desired reactions—as, for instance, the reduction of the ore and the liberation of the metal. While any kind of suitable furnace may be used, a direct-acting furnace, wherein the charge to be operated upon is placed or caused to pass directly between the electrodes and in which the current passes through the charge, is more desirable. Graphite made in the electric furnace has the advantage of great purity, sometimes containing as low as 0.033 per centum of ash, and also possessing extremely high electric and thermal conductivity, having usually more than twice the conductivity of the best conducting amorphous carbon. High electrical conductivity is of first importance—for example, when the metal on being freed from the ore combines with any free carbon or other element present to form carbides, alloys or impure

metal, and it is desired to obtain a pure metal, for instance, in reducing silica for the production of pure silicon. In making pure elementary substances—such, for example, as silicon—by direct reduction, it is essential that the contents of the furnace consist solely of the pure ore or silica and carbon in an amount not greater than necessary for the reduction. Such a mixture of silica and carbon in the amorphous condition is an extremely poor conductor of electricity, and for this reason it is impracticable to make pure silicon when the amorphous carbon is used. When graphite, however, is used for this purpose and is mixed with the silica in a like amount and in the manner above indicated, a good conductivity is obtained and a successful and practicable operation can be performed. As one example of the application of the invention, the reduction of silica and extraction of pure silicon may be described. Electrically made graphite and pure silica are taken and mixed in the proportion of graphite 55 parts and silica 150 parts. The theoretical proportion would be graphite 55 parts and silica 137.5 parts; but it is preferable to have a little less than the theoretical amount of carbon. The mixture is thoroughly rubbed together in a mortar, tumbling barrel or other suitable device. The amount and perfection of the intermingling and rubbing have much to do with the efficiency of the operation and with the electro-motive force necessary to employ for passing the electric current through the mass when in the electric furnace, and it should be well done. The material thus prepared is placed in an electric furnace in such manner that the current passing from electrode to electrode will pass through it, and around the charge on the bottom, side and top is placed a fine silica as a support and covering to the mixture and lining to the furnace, which may be made of brick or other suitable material. The mixture having been placed in this manner in its envelop of silica and in direct contact with the opposing electrodes the current is caused to pass in sufficient volume and for sufficient time to produce the reduction of the silica and liberation of the silicon. Thus in an operation which is conducted with the electrodes separated to a distance of three inches, and each having an exposed end surface of four square inches, the intervening space measuring three inches by two inches by two inches, with its floor and sides of silica, was filled with the mixture of graphite and silica above described, and over all was placed a layer of silica. The current was turned on with 100 volts. At the beginning the current registered three amperes, but quickly rose and after seven minutes registered eighteen amperes. The current was turned off after twenty-five minutes, the maximum flow having been 100 with 20 amperes. Carbon-monoxide gas escaped freely and burned on the surface. On opening the furnace a part of the silicon resulting from the silica of the charge was found as globules of pure silicon mingled with other portions of the charge not wholly reduced. These globules may be separated from the unreduced mass by floating in water or other desirable method. It is evident that various forms of furnaces may be used in carrying out the invention and that the product may be removed in many ways. Thus it may be removed intermittently either in a fluid or solid condition, as is the practice in making carborundum, carbide of calcium and aluminum continuously, either of a solid, liquid or gaseous state. When the product of the operation is a volatile metal and can be removed from the furnace in a gaseous condition, as in the reduction of zinc and other metals, suitable condensing chambers are provided for its reception and retention. When alloys are to be made of two or more metals, one or more of the metals may be mixed in a powdered metallic state with the ore to be reduced, or the ores of the several metals may be mixed with the appropriate amount of graphite to produce their united reduction, and the metals when liberated will alloy together. Thus oxide of iron and silica in the proportions necessary for the production of the desired silicide of iron, when mixed with the necessary graphite and raised to the proper temperature, will be reduced to a silicide of iron. When carbides are to be made, the amount of graphite employed in the charge is increased over and above that necessary for the reduction to at least the extent of the amount necessary to combine with the metal and form the desired carbide.

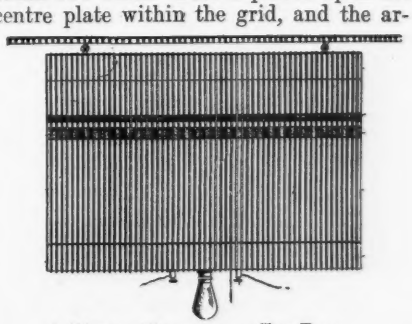
A Frenchman named Armand Le Febre, residing in Paris, has patented in this country an ingenious support for incandescent electric lamps, the patent being now controlled by the Electric Light Boards, Limited, of London, England. The lamps may be of the usual form and are provided at their base with metallic caps to which one end of the filament is connected. The other end of said filament is attached to a stem projecting from the central portion of the cap, this stem, of course, being insulated therefrom and having screw threads at its exposed end. The support for the lamps consists of two spaced-sheet conductors which may be of wire netting or other material which will permit the passage of the screws therethrough. These nettings are held a suitable distance apart by insulating blocks, and each is connected to one of the poles of some source of electrical energy. To attach the lamps it is only necessary to pass them through one of the sheets of



Support for Incandescent Lamps.

netting so as to bring the metallic cap against one and the screw stem into engagement with the other, thus completing the circuit. The arrangement is especially useful for advertising purposes, as any one may arrange the lamps in any desired form, and the grouping may be changed as often as desired.

An electrical fly-trap has been patented by an inventive genius residing in Providence, R. I., Mr. Edwin R. Greene, by name. A frame is employed which is constructed of insulating material and comprises a central longitudinal plate and top and bottom bars, the whole being connected by intermediate strips. Around this frame are wound sets of positive and negative wires spaced a slight distance apart to form a grid, the spaces between the wires being such that should a fly alight on the grid it will necessarily touch two wires. Bait is placed upon the centre plate within the grid, and the ar-



A Novel Electrical Fly-Trap.

rangement is connected up with an electric current. A horizontal platform is suspended beneath the trap to catch the flies that may be electrocuted. The operation of the device will be apparent. The insects attracted by the bait within the grid will alight upon the wires and be electrocuted, whereupon they will drop down upon the horizontal platform, this platform being so arranged that it may be cleaned as often as desired.

News from Great Britain.

(By Our Special Correspondent.)

THE coronation illuminations threaten to easily eclipse all previous attempts, as far as electrical applications in this direction are concerned. In London already the fitting up of buildings has been commenced and the effects produced should be most striking. One of the most important advances made has been the introduction of the flexible strips and boards by the Electric Lighting Boards, Limited, which allow of any design being picked out by means of special lamps which can be stuck into the conducting material at any desired point. An interesting contretemps has occurred in connection with the illumination to be carried out by the Westminster City Council. As the result of an open bid, an Italian firm quoted thousands of pounds below the lowest British tender, and were consequently recommended for acceptance. On the publication of the tenders, however, the Electric Lighting Boards Company offered to do the work on an amended tender for five per cent less than the Italian firm, an offer which was quite rightly refused. This would tend to show that English firms do not always quote at their lowest price. Electricity supply works in the provinces are making special provisions for a supply during coronation week, the majority of undertakings offering power at a reduced tariff and in some few instances a free supply for illuminations is to be given.

Mr. Yerkes has made another move toward realizing his ambition to electrify London's means of communication. Following upon the registration of the Metropolitan District Electric Traction Company, which was originally intended to equip the District railway, Mr. Yerkes has now, in conjunction with Messrs. Speyer Brothers, Messrs. Speyer & Company and the Old Colony Trust Company, of Boston, promoted another concern of much greater magnitude called the Underground Electric Railways Company of London, with a capital of £5,000,000, which will absorb the Metropolitan District Electric Traction Company and further undertake the equipment of a number of other tube railways which have already been sanctioned by Parliament, *viz.*, Great Northern & Strand Railway; Baker Street & Waterloo Railway; Charing Cross, Easton & Hampstead Railway, and the Brompton & Piccadilly Railway. In the power-house, which is to be at Chelsea, polyphase machinery is to be erected, and some twenty substations will be fed from this. A syndicate is to be formed by Messrs. Speyer to take the whole of the share capital of the new company.

Apropos of London tube railways, a House of Lords committee commenced its sittings this week to consider no less than fourteen fresh proposals, and the enormous interest taken nowadays in these proposals was fully evident by the rush of counsel and others to gain admittance. So far the most important part of the proceedings has been the evidence of Lieutenant-Colonel Yorke on behalf of the Board of Trade, in which he expressed the views of the latter body in a general way. These were substantially the same as those given in connection with the Liverpool overhead railway accident and mentioned in my last notes. He goes a little further now, however, and wishes to increase the size of tunnels to thirteen feet six inches—the Central London is eleven feet six inches—and to provide a footpath on either side of the train all through the tunnel for the purpose of assisting the passengers in case of emergency. In addition he advises the lighting of the tunnels, not hitherto attempted, and that no line shall be constructed until all the plans, etc., have been approved by the Board of Trade.

The Charing Cross & Strand Electricity Supply Corporation, which some few years ago was instrumental in obtaining the necessary powers which enabled it to compete in the city of London with the electric lighting company of that name, has nearly finished building its new power station which is situated some five or six miles out of London. As a matter of fact a supply has been given in the city for some time now, but the final capacity of the generating station will be 1,500,000 eight-candle-power lamps. Another company which will generate in bulk and supply current to two West End supply companies, *viz.*, the Central Electric Supply Company, will be in full working order before next winter's load arrives.

Telephonic matters are receiving more than usual attention recently, chiefly through a number of enquiries having been held into the application of some local bodies for loans to work Post Office licenses. The Brighton corporation has been granted a license for twenty-five years, and the Postmaster-General has fixed the minimum charge at £7 for unlimited service and a message rate of £3 10s. 1d. for call. An original service is to be designed with a capacity of 2,000 subscribers from which the estimated revenue will be £11,469 and the expenses £10,269. As a matter of fact, the subscriptions have been fixed at £5 10s. per annum for unlimited service and £3 10s. 1d. on the message-rate system. The National Telephone Company is at present charging £10 and £8 10s. for any subsequent instrument for unlimited service, and £3 10s. 1d. for call.

The ceremony of laying the first municipal telephone duct in Portsmouth has taken place, and Swansea, Aberdeen and other places are well satisfied with the promised support for the municipal schemes. The first year's working at Glasgow has just been completed, and although the figures sound somewhat on the small side in point of numbers, the efforts of the municipality to provide a cheap and universal telephone service have undoubtedly been successful. There are at present 4,524 subscribers and orders for connections amount to about 6,000. Two new exchanges have been opened and some half a dozen others are well on the way toward completion.

The British Insulated Wire Company just announced the amalgamation of that firm with the Telegraph Manufacturing Company, of Warrington. As a matter of fact the negotiations are not quite complete, but the resignation of two British Insulated Wire directors to make room for three representatives from the Telegraph Manufacturing Company is sufficient guarantee that the combination will be carried into effect.

The South Wales Electrical Power Distribution Company, which obtained a bill a couple of years back to supply "wholesale" electricity over an area of something like 1,000 square miles, has just laid the foundation of its generating station at Iveforest. Already several agreements have been entered into with small villages, etc., and no doubt the work of equipment will be pushed forward speedily.

In the House of Commons a week ago it was stated that no public service would be rendered by making known the amount of money which the government has paid up to date for the use of the Marconi wireless telegraph system and the purchase of instruments for the navy, nor in giving the number of ships upon which it was in use. One can not conceive what harm would have been done in giving the desired information.

University College, London, is just now making an appeal for funds in aid of higher education and research in London. Having attained an age of seventy-five years, this valuable institution fixes the necessary amount for enlargement of college buildings and the proper endowment of the professional chairs at something like £1,000,000.

A development brought to light during the course of the government enquiry into the London tube railway bills mentioned at the beginning of these notes, is the advent of Mr. Pierpont Morgan, who appears to be on very friendly terms with the London United Electric Tramways Company. Mr. Morgan is helping to finance a most important line running from the extreme west of London, right through the heart of the city, to the extreme north and northeast.

Mr. A. Dow, of the Edison company, in New York, recently attended a meeting of the Institution of Electrical Engineers and opened the discussion on a paper on "Problems of Electric Railways." His speech was a distinct contrast to what is usual at these meetings and Mr. Dow's witticisms were greatly appreciated.

The Board of Trade report on the accident which occurred last Christmas on the Liverpool overhead railway is not pleasant reading. The government inspector states that the defective motor, which was the cause of the fire, would have produced no serious results had the driver of the train acted with a moderate degree of prudence. Instead of this particular motor being disconnected and the train run into the station with only one motor, repeated efforts appear to have been made to bring it into action, and the fire followed as a result of the flashing produced in these efforts. Further, instead of the passengers being hurried out of the train, they were evidently told to remain in their seats. The result of this catastrophe has led Mr. A. P. Trotter, the electrical adviser to the Board of Trade, to make some valuable suggestions which are well worthy of consideration. He deprecates the use of flexible cables, and advocates a flexibility only at necessary points which could be provided by pinned hinge or knuckle joints, shunted by bare flexible links of wire gauge, or some other sound mechanical mode of construction. No woodwork should be utilized in the drivers' cabs of motor coaches, and the controlled switches should be placed outside the cab if possible.

The Mersey steam railway, which is undergoing electrification at the hands of the Westinghouse company, is making rapid progress, and the contractors are said to have earned the full confidence of the directorate.

The ventilation of the Central London Railway is receiving earnest attention, and a system of drawing the foul air from the tunnels every night after the stoppage of the trains by means of monster electric fans is under trial. A. W.

London, May 3.

Artificial Graphite.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In a paper read by Mr. Bertram Blount before the Manchester section of the Institution of Electrical Engineers, part of which is published in the ELECTRICAL REVIEW of May 3, 1902, there are certain erroneous statements made in connection with the production of artificial graphite by the Acheson process. Mr. Acheson's work is so well known in this country that it seems scarcely necessary to point out these errors. Nevertheless, in case there may be some who are unacquainted with the Acheson process of manufacturing graphite, it may be well to call attention to certain facts which Mr. Blount could easily have obtained by consulting the literature that has been published in connection with Mr. Acheson's work.

Mr. Blount gives the three methods of producing graphite described by Moissan: (1) Simple elevation of temperature; (2) separation by cooling from solution; (3) separation by displacement from solution. He then goes on to say: "The preparation of graphite on an industrial scale has already been attempted by Acheson, and from the published descriptions of his process it appears that he uses either the second or third method. Acheson, in his U. S. A. patent No. 568,323, claims broadly the manufacture of graphite by the decomposition of a carbide, a claim which is clearly untenable, because the decomposition of a carbide and the production of graphite thereby have been known for many years."

Notwithstanding all that has been written on the subject it is evident that Mr. Blount has failed to grasp the Acheson method of producing graphite, for it is not dependent on any of the three methods given by him. In manufacturing silicon carbide, Acheson found that by raising the temperature sufficiently high he decomposed that compound, the silicon being driven off as vapor and the carbon left as graphite which preserved perfectly the crystalline structure of the silicon carbide from which it was formed. This graphite was first mentioned in a patent, No. 492,767, applied for by Mr. Acheson, May 10, 1892, and was fully described by me in the *Journal of the Franklin Institute,* February, 1897. In the same journal, June, 1899, Mr. Acheson described his invention fully, and finally I went into the subject in detail in a paper published in the *Journal of the Society of Chemical Industry,* May, 1901. The difference between the Acheson process and the three methods described by Moissan is obvious. As to previous knowledge of the Acheson method it would be interesting to know where a reference to it may be found. It can hardly have been known to the jury, under the presidency of M. Moissan, who awarded to Mr. Acheson the *grand prix* for his exhibit of graphite at the Paris exhibition, 1900.

Mr. Blount also conveys the impression that the production of Acheson graphite has never got beyond the experimental stage, but the following figures from *The Mineral Industry* (vols. vii, viii, ix), giving the production of Acheson graphite, show that it may be fairly considered a commercial product:

Year.	1897.	1898.	1899.	1900.
Production (lbs.)....	162,382	185,647	405,870	860,750

In conclusion, it is implied that the Acheson graphitized carbons are only partially converted into graphite, but it has been shown by a careful application of Berthelot's test that the conversion into graphite is complete and that they are absolutely free from amorphous carbon. This has recently been confirmed by Dr. Foerster, *Zeitschrift für Elektrochemie,* March 6, 1902.

FRANCIS A. J. FITZGERALD.

Buffalo, May 5.

A record for continuous service has recently been brought to light by reason of a pumping engine being recently removed from a Birmingham canal station after having been in constant service for 120 years.

ELECTRICAL MINING NOTES.

WINDING BY ELECTRIC MOTORS *vs.* WINDING BY STEAM.

In the United Kingdom winding is understood to mean what is called hoisting in America, that is to say, lifting vertically the tubs of coal being run on a cage which is attached to a rope that winds up on a drum on the surface. Haulage, on the other hand, means the work that horses have done before mechanical haulage apparatus is put down, *viz.*, dragging either individual tubs of coal, or trains of tubs, along a road which may be level or inclined, underground, or on the surface, or partly underground and partly on the surface. Winding engines have a very important duty to perform, and they are very wasteful in steam. It has been suggested, therefore, by electrical engineers that electric motors would be more economical. Mining engineers object that it is not possible for electric winding to be more economical than steam winding, seeing that the winding engine is always situated close to the boiler, and there are three conversions to be paid for where electric motors are used. But it is not only possible, but the economy is considerable. The lowest quantity of coal used per indicated horse-power in winding engines in this country during the operation of winding is eleven pounds, and it can be easily shown that this can be reduced to five pounds even without using very high pressures and many expansions in the main driving engines, while the above saving is not the only economy, as the winding engine is consuming coal during the whole twenty-four hours, and very wastefully, as it must always be ready to wind at a minute's notice. To meet this, Professor Galloway, some years ago, designed a winding engine with two sets of compound engines—four engines. In France they have now improved on this. The steam is first dried before it is admitted into the high-pressure cylinder. From the high-pressure cylinder it passes into a receiver where it is reheated, and from this it passes into the low-pressure cylinder. The consumption of steam on these lines is not given, but the economy should be fairly considerable, as the principal source of loss is the condensation.

CENTRIFUGAL PUMPS AND ELECTRIC MOTORS.

The development of the electric motor is bringing the centrifugal pump to the fore. Centrifugal pumps run at high speeds and therefore are very suitable for connecting directly to electric motors. In addition to that, however, makers in this country are now making centrifugal pumps to run in series with one another just as the cells of a galvanic battery do, the tail water from the first pump passing into the suction of the second, and so on. The writer saw a large pump at a colliery in Yorkshire, a short time since, consisting of three centrifugal pumps, mounted together, looking like one of those shells that are so common on the seashore, and with the bed-plate extended, in the usual way, for the motor to be attached. The pump was arranged to pump 18,000 gallons of water per hour a height of 200 feet. The motor was three-phase. The colliery is situated by the side of a river, the banks of which are very steep, and this is the method adopted for feeding the boilers. At the Glasgow Exhibition, it will be remembered, Messrs. Mather & Platt exhibited a series of centrifugal pumps which it was claimed were together capable of delivering water a height of 400 feet. The pumps themselves were of special construction, enabling a higher lift to be obtained with each pump than is usual with centrifugal pumps, but the connection of the pumps together was the same.

ELECTRIC LOCOMOTIVES *vs.* ROPE AND CHAIN HAULAGE, ELECTRICALLY DRIVEN.

German mining engineers have been going somewhat deeply into the advantages of locomotives and ropes or chains driven electrically. The electric locomotive has not been adopted at all in this country for mining work, though it has been taken up so much on the Continent and in America, the principal reason being that so many of our mines are fiery, and the government, represented by an able body of inspectors, keeps a very tight hand upon anything which is likely to increase the danger to the working miner. The coal seams worked in the United Kingdom are nearly all at considerable depths, owing to the shallow seams having been worked out, and the quantity of gas present in the coal increases very rapidly as the depth increases. In shallow seams the gas has opportunities of escape to the surface, but in deep seams it has been compressed into the coal itself, and into small fissures caused by the working of the strata. What are termed faults, which consist of movements of the strata up or down, leaving a break in its continuity, and a minute fissure of microscopical section, often hold enormous quantities of gas under great pressure which comes away immediately the pressure is removed by the working of the coal in the mine. Consequently it would not be safe to have trolley wires running in the bulk of the coal mines in this country. Our German friends, however, report very favorably on electric locomotives as against rope or chains driven by electric motors. They point out quite justly that the friction of the ropes is a very serious matter and quite outweighs any loss caused by the conveyance of the current into the mine for the use of the locomotive, and it also outweighs the increased friction caused by the increased weight of the locomotive necessary for adhesion.

A MINE WORKED BY ELECTRIC CURRENT FURNISHED FROM BLAST FURNACE GAS.

The gases emitted from the iron smelting furnaces—the blast furnaces as they are termed—have long been a source of anxiety to the engineer. They represent an enormous quantity of wasted energy which might be employed for many purposes. A portion of the energy has been so employed for a long time to fire the boilers which furnish steam for the blowing engines, the engines which provide the blast, and another portion has also been used for a long time to heat the air which is forced into the furnace, so that the damping effect of cold air may be avoided. But there is still a very large amount of energy going to waste. Messrs. Cockerill have lately put up a plant to utilize it, and one of the iron-making firms in Scotland has had a small plant using blast furnace gas for driving an electric light for some years, but little more has been done in the United Kingdom. At a German colliery a recent application has been made of blast furnace gas to drive a three-phase generator made by Brown-Boveri, furnishing current at 1,000 volts in the neighborhood of the blast furnace, which is transformed up to 10,000 volts and transmitted to the mine, a distance of four miles, by means of three copper wires three-sixteenths of an inch in diameter. At the mine it is transformed down to 1,000 volts, and at that pressure is used for driving an endless rope haulage plant, the road over which the road travels being another mile in length. The mine is worked by an adit or level tunnel. The work done is over 4,000 ton-miles per day, and the cost is stated to be one halfpenny—say, one cent—per ton per mile. This is very low as compared with the cost of haulage in this country, the lowest being one penny per ton per mile. It is also stated

that when the plant is fully employed the cost will come down to three-eighths of a penny per ton per mile.

A NOVEL USE FOR ELECTRICITY IN MINING.

A very novel use of electricity in mining operations is reported from Germany. For photographing the inside of a bore hole, either when water or oil is present, presumably when boring for oil, in the latter case, a tube of calcium carbide is let down into the hole together with a box containing a camera, an incandescent electric lamp, which is inside a bell, and an apparatus which lets water on to the carbide by means of the electric current. The acetylene gas liberated by the water acting on the carbide forces the water or oil out of the bore hole, lights the incandescent lamp and puts the camera in operation, taking a picture of the inside of the bore.

DYNAMO INSULATION.

BY CHARLES E. FARRINGTON.

Generator insulation has a vital function. Upon it depends the efficiency and repair expense of a central station. The general defectiveness of such insulation arises from inattention to the subject by constructing engineers. "Why should we go to the expense of chemical and mechanical research work when our sales department has our factory booked with orders for a year ahead?" "We don't get many complaints on poor insulation which our salesmen can not readily take care of."

Those two excuses for procrastination have made the improvement of insulation lag far behind the improvement of mechanical construction. In fact on a great proportion of the work of to-day the insulation is mechanically supplied with the hope that a vast mechanical margin of safety will take care of known or suspected chemical defects.

The study which has been made of papers and fibrous stocks has done little more than develop a list of defects which the paper and paper-board makers are earnestly trying to correct. Some of the mica miners are learning to keep mica containing fluorine and metal away from the electrical fraternity. Some of the "built-up mica" makers have learned to use as little varnish as possible, and they are all looking vainly for a non-acid cementing varnish with which to work.

Competent varnish chemists admit this to be an utter impossibility until a varnish material is discovered which shall be non-acid bearing.

The application of this fact to coil insulation throws a great deal of light upon the questions of efficiency and repairs.

All varnish material carries a large volume of acid, seldom less than ninety per cent. This acid forms a most prolific cause of efficiency drop and causes a very large proportion of the repair expenses which occur. This ninety per cent does not all appear as corrosive or "free" acid, but it is readily set free by heat, association with hot lubricating oil, electrolytic action or by ozone.

Free acid replaces its hydrogen atoms with atoms of copper whenever it has an opportunity. Under heat and electrolytic stress there can be no doubt that in the exchanging state the metal is vaporized and is nearly as good if not a better conductor than the solid copper from which it comes. If the varnish absorbs the metal while the generator or motor is at rest nothing worse than a drop of efficiency results. If the vaporized metal is developed in a working machine a short-circuit inevitably results. It will carry short-circuits through thick fibre and through mica one-eighth of an inch thick with an electro-motive force of ten volts.

This acid action is a subtle one and the resulting breakdowns are easily explained by a glib salesman or repairer. The central station man is seldom equipped with a chemist's training, and "lightning discharge," "too little care by your oilers," "circuit-breaker didn't work quick enough," go easily as excuses to make the station bear repair bills which the builder should assume.

Many generator builders take pride in stating that they use that insulating varnish which has shown the highest resistance by their tests. But the insulation resistance of a varnish is no more a guarantee of its real value than a man's name is a description of his character. It may sound good, but it gives no idea of the traits or disposition which will subsequently be disclosed by better acquaintance.

A high-resistance test result merely classifies an insulating material as such, but the permanence of that classification does not extend one instant beyond the time duration of the test. Of the hundreds of varnishes which may be used as insulation the "highest" is the least useful in long-service tests. What is wanted is a material which permanently retains a reasonable margin of safety.

If "necessity is the mother of invention," so the demand of purchasers is the father of production. Central station men can only get immunity from armature leakage or from shut-down and repair losses by persistent demands for the use of insulating compound which will obviate the necessity of indefinite excuses for those repairs.

Any insulating material or compound which is used to reenforce cotton, fibre or paper in armature or field coils should permanently maintain its insulation resistance and withstand overload heating. It must not become brittle and full of cracks or the armature will be lost when a roof leaks or a steam main breaks. It must be free from acid.

Real insulation must exclude oxygen mechanically and not absorb it chemically. It must not be decomposed by ozone, as every armature is an ozone generator. It must be permanently plastic and self-healing and thoroughly tested under the service conditions of all climates. It must not set up an acid action when oil gets into it, but should absorb the oil without the slightest trace of a chemical disturbance.

It only needs a little careful testing to determine that oil and "oil dirt" are good insulation and that the "oil can short-circuit" is a fairy tale which came from the electrical nursery with less foundation of fact than the story of "Jack and the Beanstalk."

Central station men have this matter largely in their own hands. Pay a little more for a generator and get a five-year guarantee against losses arising from chemical deterioration of insulation.

Study insulation as you study the working parts of a machine. Specify results and not "the best insulation" for that is only a matter of opinion. Don't try to get fancy colored armatures.

Watch your repair men. They like to follow the builder and "put your machine in as good condition as when new." When they ask: "Doesn't it look just the way it did the day it came?" ask them if it has all the improvements which chemical science has provided since it was built. You are paying for new work, up-to-date work, not old-style work. Repair men should be educated out of the idea that a machine owner will "kick" if its appearance or color has been changed. The best-looking armature is the one which will run the longest. If artistic decoration is wanted, save its cost on the armature (in future repairs) and buy an oil painting to hang on the station wall.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Electric Towboats.

Some account is given in a Spanish contemporary of the new electric towboats recently put in service by a German concern between Berlin and Zehndenick. These vessels are about fifty feet long, eleven feet beam, and only three feet six inches draft, and can carry cargoes of 150 tons. The principal advantage of these vessels resides in the relatively small displacement of water which is much less than that of steamboats of equivalent power. In consequence, they can be used with great advantage in canals and other places where the water is not very deep and where there are many short curves to be taken. These vessels have shown great economy and it is thought that their use in the neighborhood in which they have lately been installed will increase.—*Revista de Obras Publicas* (Madrid), April 17.

Vibration and Incandescent Gas Burners.

In a recent study on the influence of vibration upon incandescent gas burners Herr G. Rothgiesser has discovered that electrical vibrations as well as sound vibrations cause a considerable increase in the illuminating power of a burner in which the gas supply is in excess. They seem to exert a favorable action upon the mixing of gas and air in the burner itself. It is thought that this action may afford some explanation of the capriciousness of the incandescent gas burner which has not hitherto been accounted for. Great differences in the illumination given off by these burners may be obtained according to whether the room is permeated by sound vibrations or not, while even reflected light may have something to do with the luminous output; the temperature of the entering gases also largely affects them.—*Der Gastechniker* (Berlin), March.

Luminous Bacteria.

Great interest has been shown lately in the study of light-giving bacteria. Some of these minute organisms seem to have the power of absorbing oxygen and emitting light, much as other and more highly organized bodies emit heat under similar circumstances. Up to the present about twenty-five species of light-giving bacteria have been isolated, though it is considered probable that some of these are identical with one another, or at least closely related. It is found that in artificial cultivation these organisms grow best in a medium containing a considerable percentage of a soluble chloride. Temperature seems to have a large effect upon the emission of light. The light emitted is all in the visible spectrum, including only the green and blue and some part of the violet of the spectrum. In some cases the light emitted is of considerable power. Dr. J. E. Barnard has described his investigations of these interesting bacteria at some length and with several illustrations in a British contemporary.—*Nature* (London), April 10.

British Telephone Statistics.

Some very interesting statistics of a municipally owned telephone plant have just been published by the Guernsey States Telephone Department for the year ending December 31, 1901. Until very lately it has been practically impossible to obtain telephone statistics from Great Britain on account of the monopoly in telephone affairs in that country. In the plant referred to it appears that there are 881 subscribers' lines and that the capital cost per line has amounted to $89.50 per line. This also takes in some one hundred spare or partially completed lines, which brings the actual cost down to something like $82.50 per line. The average revenue from a subscriber's line has been $14.75 per year. In spite of this low figure the department, after paying interest on its borrowed capital, royalties to the post office, working expenses, etc., was able to set aside ten per cent on the total capital expenditure for depreciation and sinking fund and to show over this a profit of $600 for a dividend. These are practically the first figures that have been published of a British telephone enterprise.—*The Electrical Engineer* (London), April 25.

A Horizontal Telephone Switchboard.

The new telephone exchange at Hamburg, Germany, is equipped with a horizontal switchboard, which is claimed to have many advantages over the ordinary upright type. The principal advantage claimed is economy in the number of jacks required and length of board, and, consequently, in the space occupied. On account of the sections being horizontal instead of vertical, operators can work from both sides of the board and consequently each section can—in theory, at least—carry twice the number of answering jacks that a vertical board can accommodate. For a given number of lines, therefore, a horizontal board is only half as long as a vertical board, although it occupies more ground space breadthways. A large number of such boards has been supplied for the Imperial German Telephone Department, and the switchboard at Glasgow, Scotland, is also of the same general type. It seems rather as if such boards would have certain disadvantages that would more than compensate the increase in economy in jack space. For one thing, all their back connections would be covered up and hard to get at as compared with the simple arrangement of the vertical board which allows repairs and connection work to go on at the back with great facility.—*The Electrical Engineer* (London), April 25.

Blast Furnace Gas Engines.

An interesting note describes recent European experiments with internal combustion engines using the gases derived from blast furnaces. The first trials were made in Europe in 1894, and by 1900 a machine of 750 horse-power was exhibited at the Paris Exposition. The average heating power of blast furnace gas is 980 calories per cubic metre. In the majority of the engines the compression before ignition runs up to from 120 to 135 pounds, and without ignition the cylinder pressure is as high as 240 pounds. The indicated horse-power output amounts to a little over thirty per cent of the theoretical possible total, the losses being twenty-four per cent, carried off in the

cooling water surrounding the cylinders and forty-six per cent in the gases. A fifty-horse-power motor has been brought up to a consumption of 1.4 cubic metres per kilowatt-hour. About thirty-five gallons of water per hour for cooling are required for each horse-power, while one pound of grease or oil per hour for twenty horse-power is the average consumption of lubricant. The furnace gases contain about four grains of dust per cubic foot, of which about three grains are deposited very easily before reaching the engine, and nine-tenths of the balance is stopped in the purifiers.—*L'Industrie Electrique* (Paris), April 10.

An Interesting Example of Polyphase Traction.

At Neustadt, near Vienna, an interesting little plant for polyphase traction at 3,000 volts has just been installed for the government arsenal. The object of this line is to connect the arsenal with the Schneeberg railroad, some two-thirds of a mile distant. The arsenal already has installed a machine-shop driving plant operating at 3,000 volts and forty-two cycles per second. It was decided, therefore, to apply this pressure directly to the railway line. The locomotive consists of a thirty-six-kilowatt three-phase induction motor geared to the wheels and fed from two trolley wires upon which the usual European bow trolleys are employed. The track is used as the third element of the circuit. The locomotive is provided with an air compressor for brakes and also for the operation of the controller which is indirectly handled with compressed air. The locomotive greatly resembles those constructed by its makers, Ganz & Company, for the Valtellina railways in Italy. The line has now been in operation about three months and has given the greatest satisfaction. It is considered to have demonstrated that the use of 3,000 volts alternating on a trolley wire is relatively simple and easy and commercially economical.—*L'Industrie Electrique* (Paris), April 25.

The Study of Electric Oscillations.

An ingenious and very beautiful method of studying the damping out or dying out of rapid electrical oscillations has been described by Herr J. Zenneck. The apparatus used is the familiar Braun cathode ray tube, a luminescent screen being used to receive the trace of the cathode discharge and proper movement given it to combine the vibrations produced by the oscillating current and a known motion at right angles. The trace of such oscillations on the screen consists of a line of beads or bright spots extending both sides of a bright centre and becoming fainter and wider apart the farther they are away from the zero or middle position. These beads are the turning points of successive oscillations. They become visible owing to the reduced velocity of the cathode stream at these points, and hence the distances between the beads and the zero position mark the successful amplitudes of the oscillations. When a large number of discharges take place in rapid succession under identical conditions the beads appear stationary and may be photographed. They form a very delicate test for the regularity of the discharge and show the influence of inductance, resistance and other constants of the circuit. The author has succeeded in reproducing photographs obtained with a frequency of over one million per second, the deflection being either electrical or magnetic. —*Annalen der Physik* (Berlin), April.

Is Lightning Oscillatory?

Dr. Walter, of Hamburg, has conducted some interesting and valuable experiments on the determination of whether or not lightning discharges are of an oscillatory character. The apparatus consisted of a photographic camera mounted on a vertical axis and rotated at a uniform rate by clockwork. The observations were made from a small cabin erected on the roof of a high building and provided with windows directed to the four points of the compass. A number of very fine photographs of flashes showing a number of separate discharges over the same path were obtained. The time intervals, calculated from the movements of the apparatus, were found, contrary to general anticipation, to be highly irregular, so that it is almost definitely proven that the discharge is not really oscillating in character. In addition to this irregularity of the succession of the flashes, it was found that the first and last flashes over the same course were generally the brightest, whereas if the flashes were oscillating in character there would be a regular dying down or damping out of energy in all the succeeding flashes after the first one. In some cases as many as six separate discharges in one flash were exhibited. The time intervals obtained in one case of six discharges were 0.131, 0.068, 0.075, 0.119 and 0.103 second, respectively. It is considered that here any regular oscillation of electric currents between the cloud and the earth is quite out of the question. In almost all cases where a discharge takes place between the cloud and the earth the author concludes that the cloud is positive to the earth. The tendency of the positive discharge to strike out laterally in forked branches is clearly shown in some of these photographs. The results obtained are not only of great interest, but may go far toward the establishment of an understanding of the fundamental nature of lightning. —*Physikalische Zeitschrift* (Berlin), March 1.

"Economizers" for Incandescent Lamps.

In a recent note before the French Academy of Sciences an ingenious system of increasing the general efficiency of incandescent lighting devices was described by MM. G. Weissmann and André Blondel. These authors state the well-known fact that incandescent lamps with carbon filaments can not be made below five candle-power for pressures of about 100 volts, since the filament required is smaller than can be commercially manufactured and handled. They point out that the efficiency of a carbon filament also depends to a large degree upon the size and candle-power of the lamp. For example, speaking of commercial efficiencies and 110-volt lamps, the 32-candle-power lamp will show three watts, the 50-candle-power lamp 2.5 watts, and the 100-candle-power lamp 2 to 1.8 watts efficiency. It appears, therefore, that large filaments show higher efficiency in luminous output than the smaller ones and also possess greater steadiness in burning on account of what may be called their heat inertia. The economizer system suggested consists in putting a very small transformer in the circuit of each group of lamps, so arranged that its primary is cut in or out by the lighting switch. For example, in place of using 10-candle-power 110-volt lamps with fine filaments which consume four watts per candle-power, lamps of 22 volts and 10 candle-power may be installed consuming only 2.5 watts per candle-power. At 22 volts lamps of 1 candle-power may be made very satisfactorily. The small transformer may be made of very high efficiency, going up to ninety-seven per cent for sizes up to 300 watts. They are always worked naturally at full load, and as their primaries are cut out when the lamps are extinguished, can not produce phase displacement or all-day core losses. It is stated that several thousand lamps have already been installed in Paris on this system, and during the eight months they have been in operation have given generally excellent results.—*L'Industrie Electrique* (Paris), April 25.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electrically Operated Air Compressors.

One of the most remarkable developments in the recent history of engineering progress is the constantly increasing use of compressed air as a medium of performing numerous and various industrial operations.

Pneumatic tools and other appliances for the utilization of compressed air have been introduced into one field after another with such successful and gratifying results that the advantages of using compressed air for a wide variety of purposes are now fully recognized.

MOTOR-DRIVEN COMPRESSOR, TYPE L.

The present general use of electricity renders it advantageous to operate air compressors with electric motors. The convenience and economy of this method are apparent when it is remembered that an electrically driven compressor can be operated from any lighting power or railway circuit that may be available.

To meet the constantly increasing demand for an electrically driven, simple, compact air-compressing unit, the Christensen Engineering Company, Milwaukee, is manufacturing a complete line of motor-driven compressors ranging in capacity from 7½ to 1,000 cubic feet of free air per minute. The smaller sizes are made for portable as well as stationary service.

The type "M" motor-driven air compressor illustrated herewith is for stationary continuous service. It is built in capacities from 50 to 1,000 cubic feet of free air per minute.

The electric motor and the compressor have been designed to form a compact self-contained unit. The air is compressed in the cylinder, shown on the left, by a double-acting piston which is operated by means of a connecting rod and steel crank shaft. The latter is mounted in bearings located within the frame of the machine. This shaft carries on the motor end a helical gear which is driven by a pinion on the armature shaft of the motor. The entire machine is mounted on a substantial cast-iron base.

Both the cylinder and the valve heads are water-jacketed throughout. The clearance spaces have been reduced to the lowest practicable limit, thereby correspondingly increasing the economy.

The suction and discharge valves are arranged in cast-iron heads bolted directly to the cylinder. They consist of seamless, cold-drawn steel cups, so arranged that each is removable independent of the other. No springs are used with these valves. They are operated by the compressed air itself and are reseated by gravity. The peculiar construction of these valves renders a small lift possible, hence the noise from their operation is reduced to a minimum. The suction and discharge valves are identical and interchangeable. Only one connection is necessary when piping from the compressing cylinder to the reservoir.

The piston is provided with an improved form of packing rings which are carefully fitted in place so that they form as near a perfect sliding joint as can be obtained. The piston rod is of steel, carefully ground true on dead centres. The rod passes through a self-adjusting metallic packing box.

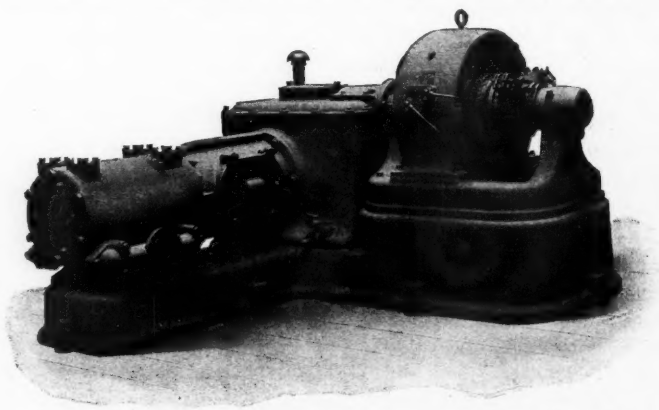
The connecting rod is composed of steel and is arranged to receive oil for lubricating the crank pin, wrist pin and piston.

The cross-head is provided with adjustable shoes of extra large area and with an accurately ground-hardened tool-steel wrist pin which fits into a phosphor-bronze bearing in the rod.

The crank shaft is composed of a high-grade steel, and is provided with extra large bearings, thus avoiding the frequent adjustment of the bearing boxes which is usually necessary with bearings of ordinary size. The shaft is carefully balanced and accurately turned true to receive the connecting rod.

The crank shaft is extended at the motor end to carry the gear which is driven by a pinion on the armature shaft of the motor. The gear and pinion are of the helical herring-bone type with teeth cut by special machinery in the most perfect manner, thereby reducing the noise so that it is almost unnoticeable.

The gear case and the crank chamber are connected and form an enclosure which is partly filled with oil, with which all the working parts are automatically and continuously lubricated, including the air cylinder. The latter is connected with the oil chamber so that the proper quantity of oil for lubricating the surface between the cylinder and the piston is automatically supplied and no sight feed lubricator is required. The motion of the crank shaft in the oil causes continuous lubrication of the main bearings, the crank-pin bearing of the connecting rod, the cross-head guide, the piston rod, the wrist pin in the cross-head and the piston.



AIR COMPRESSOR FOR STATIONARY CONTINUOUS WORK, TYPE M.

Oil is also supplied automatically to the bearings at the pinion end of the motor. The gear and pinion operate continuously in the oil bath. The machine will remain lubricated as long as the oil is kept up to a level determined by a filling plug on the side of the crank chamber. Experience has shown that after being supplied with oil, the compressor runs for several weeks before replenishing is necessary.

Either an alternating or a continuous-

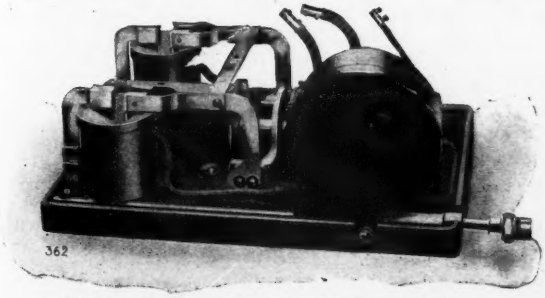
current motor may be used. The illustrations herewith show the continuous-current, multipolar type that the Christensen company builds for this service. The lower frame of the motor is of cast iron and the field is composed of low-carbon cast steel with detachable steel pole-pieces. The motors are series wound and are started and stopped without using resistance of any kind. The armature is of the latest ventilated type, built up of discs of soft steel and slotted to receive the winding. Machine-formed armature coils are used; the insulation and other materials are of the highest grade obtainable. The commutator is built up of hard-drawn bars of the best lake copper, insulated from each other by segments of mica. The armature shaft revolves in extra long bronze bearings with ring oiling arrangement. The bearings are so designed that it is impossible for oil to get into the armature.

The brush-holder is of the simplest possible construction. It is provided with an instantaneous tension adjuster arranged so that the tension can be increased while the motor is running.

The design of the motor and compressor is such that every part is easily and quickly accessible.

By unscrewing a few bolts the armature and the field coils can be removed or exchanged. The gear, pinion, valves or cylinder heads may also be removed without disturbing any other part.

Access to the cross-head and wrist pin is obtained by doors conveniently arranged on the side of the slide frame.



Automatic Governor for Air Compressor.

The crank chamber is constructed so that it is completely closed, but the upper part may be quickly removed, giving free access to all the working parts, while a smaller hand hole covering is provided and may be easily removed for inspection of the interior.

An automatic governor starts and stops the motor compressor at the desired minimum and maximum pressures. It is a very simple piece of apparatus, consisting of an ordinary pressure gauge mechanism with a special hand, which, upon coming in contact with a conducting stud at the position of minimum pressure, allows current to flow through a magnet coil. This coil operates a plunger, to which the contact pieces for the motor circuit are attached, thereby closing the circuit and starting the motor to work.

As soon as the pressure reaches the desired maximum the hand strikes another stud and current passes through a second solenoid magnet, thereby pulling the plunger in the opposite direction and opening the motor circuit. By this mechanism it is possible to get a close margin between maximum and minimum pressures. This margin is readily adjusted by moving the contact studs.

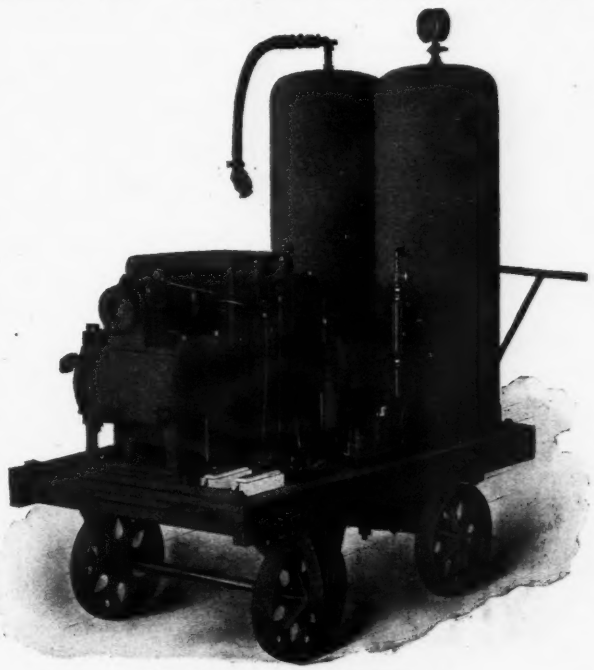
The governor is provided with a magnetic blowout for extinguishing the arc and preventing the burning of the contact pieces.

All the working parts are easily accessible for inspection and the governor is protected by a cover, not shown in the illustration.

A smaller compressor for stationary continuous service is built in capacities from four to thirty-five cubic feet of free air per minute.

These are known as type "L," and they are similar in design and construction to type "M," described above. The motor is mounted directly over the compressor instead of on the side. The compressor has two cylinders which are water-jacketed throughout. Each cylinder is provided with a single acting plunger piston which is operated by a connecting rod from a well-balanced steel crank shaft. The shaft is extended at one end to carry a helical gear which is driven by a pinion on the armature shaft of the motor directly above. The base of the motor forms a cover for the compressor frame and the gears are also enclosed in a suitable casing. The interior of the compressor is therefore completely enclosed and protected from injury. This compressor is a modification of the type "H," the water-jacketing feature being added to make it suitable for continuous service. (The type "H" is the Christensen motor-driven compressor, well known in the electric railway field. More than 5,000 of them are in daily and highly satisfactory use in connection with the Christensen air-brake equipments on electric cars throughout the world.)

The suction and discharge valves are of seamless cold-drawn steel. They are conveniently arranged in the cylinder back cover so that each is independent of the other and separately accessible.



Portable Air Compressor.

The illustrations of the type "L" herewith show the well-known continuous current type that the Christensen company has made for several years for use with its air-brake equipments on electric cars. They are four-pole series-wound motors with two field coils. They have cast-steel frames and cast-steel poles. All the other important features of the motor are similar to those used with the type "M" compressors.

For portable service the Christensen company mounts its type "H" compressor with the automatic governor and air reservoir on a suitable hand truck which can be easily and quickly moved wherever necessary. This portable outfit, known as type "I," has a very wide field of usefulness wherever pneumatic tools or other compressed-air appliances are used and an expensive system of piping is not desirable. The compressor is taken to the work instead of transmitting the compressed air from a stationary compressor at a distance.

These compressors are frequently mounted on a wagon instead of a hand truck, and transported by horses for use in

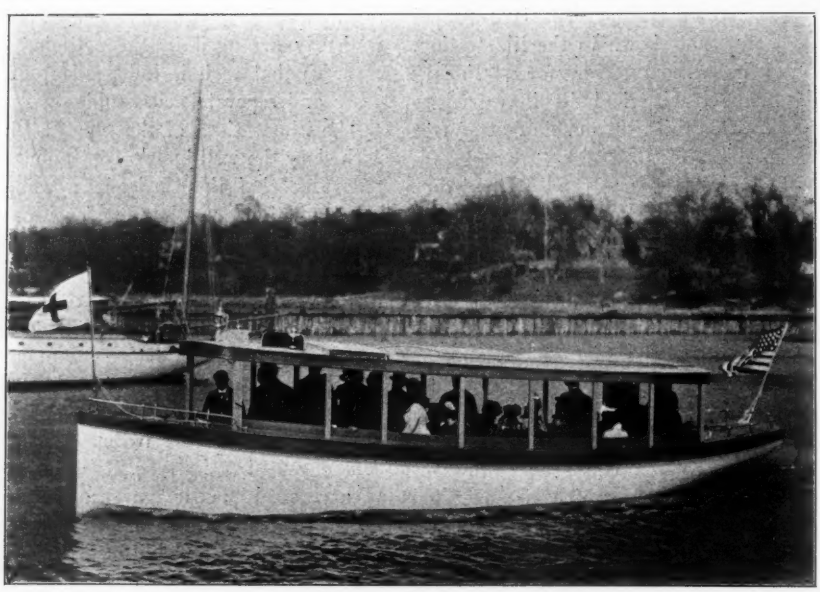
drilling and bonding rails, etc., in electric railway or other work where electric power can be obtained. It is only necessary to make a connection to the trolley by a hook or pole for the purpose of obtaining power for the motor.

It is also practicable to make the smaller sizes of the type "M" portable, especially where the truck, upon which the compressor is mounted, is arranged to run on rails.

Electric Ambulance Launch.

An electric ambulance launch, the first of this type of boat, was launched with much ceremony on May 2, at Bayonne, N. J. This was built by the Electric Launch Company, Bayonne city, N. J., for the St. John's Guild.

The motive apparatus, including batteries and motors, is placed beneath the flooring of the boat. This increases the stability and seaworthiness of the craft and places power easily available at all times. It has a storage battery capacity enabling the launch to cover a distance of sixty-eight miles on one charge, being driven by an eight-horse-power electric motor. The highest speed of the launch is about ten miles an hour. The length over all is thirty-eight feet, beam nine feet and draft twenty-four inches.



Electric Ambulance Launch for St. John's Guild.

The launch is designed especially for transferring sick children between the floating hospitals of the St. John's Guild and the Seaside Hospital, at New Dorp, S. I., the floating hospital barges anchoring about a mile off shore on account of shoal water, and has a seating capacity for forty adults or sixty children.

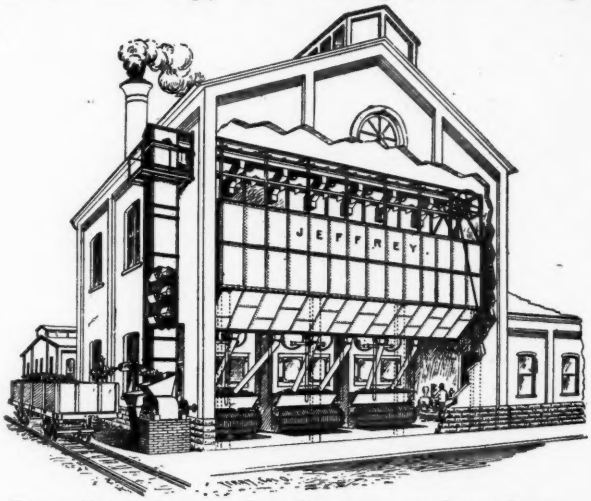
It is finished in white enamel and has three entrance hatches and a wide stretcher hatch, making an opening in the roof so that a full-sized stretcher can be lowered from the hospital barge directly into the launch without disturbing the occupant. The boat is strongly constructed of oak and cedar. The seating cock-pit is protected by a standing roof with Pantasote rolling curtains of the street-car type, which can be quickly lowered to protect the occupants from sun and wind.

When the boat was launched full power was available, and it was gotten under way under its own power immediately after touching the water. The power for recharging the batteries is obtained from the electric lighting plant of the Seaside Hospital.

This launch is the gift to the St. John's Guild of Mr. Isaac N. Seligman, of New York, and was christened the Margaret after a pretty Japanese custom by Mrs. Isaac N. Seligman, being named after her daughter.

A Fine Power Plant.

The power plant of the Jeffrey Manufacturing Company, at Columbus, Ohio, is a modern steel and brick fireproof building provided with good light and ventilation. The induced draft system is used in connection with the boilers, the boiler room being equipped with three 250-horse-power Babcock & Wilcox boilers fitted up with chain-grate stokers. This induced draft system is put in in duplicate, making provision for any accident that might occur, allowing one to be shut down and the other started without any hindrance to the working of the boilers. Modern feed-water heaters and purifiers are also installed in this plant.



Power Plant, Showing Coal Delivery and Chain Stoker.

A storage tank of 280 tons capacity provides for the feeding of the boilers, doing away with unsightly and inconvenient coal piles in front of the boilers. The coal is unloaded directly from the cars into an elevating boat, or in case of lump or run of the mine coal into a crusher which is directly over the boat. The coal is taken to the tank by the continuous Jeffrey bucket system, the tank being in direct communication with a stoker by means of chutes provided with a gate valve operated by a hand chain and wheel from the floor. The engine room is equipped with three 250-horse-power high-speed engines, belt-connected to three 150-kilowatt, 250-volt Jeffrey generators. The switchboard is of black, polished slate and especially designed and built by the electrical department for this company's particular requirements. The different departments, which are electrically driven, are furnished with power from this board, the light and power lines being independent for each one.

Power for a number of pneumatic hoists and tools throughout the works is furnished by an air compressor which is also installed in the engine room, the whole plant, while not large, being arranged to operate in the most economical manner.

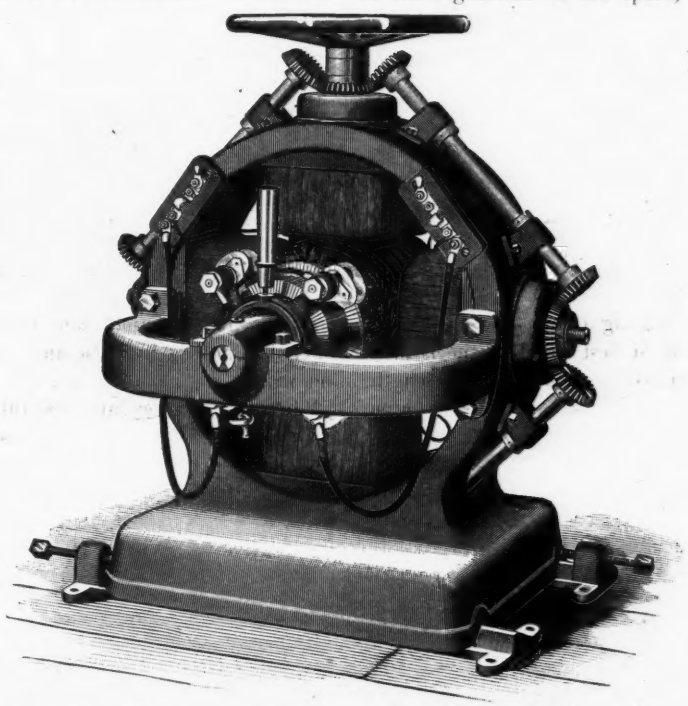
Multi-Speed Motor.

The new type of four-pole multi-speed motor, illustrated herewith, combines all the advantages of the ordinary multipolar motor with the added advantage of an operative speed range of 100 to 150 per cent from minimum speed, the percentage of speed variation increasing with the size of the machine. The armature rotates in a balanced magnetic field under all conditions of speed, this magnetic balance being secured by a simultaneous radial adjustment of four plungers by means of a bevel gearing, a hand-wheel by which the plungers are moved being located conveniently at the top of the machine.

The design of the pole-piece and the selection of gearing are such that no great effort is required at the hand-wheel in order to move the plungers against the tractive power of the field magnets. As the gears are small, the gear rods lie close to the frame of the motor, this mechanism does not detract from the otherwise symmetrical and pleasing design of the machine.

In common with other closely designed multipolar machines, the various parts of the machine are arranged very compactly and the design secures a substantially reduced weight at a given speed over the bipolar form. The base of the motor is cast integral with the frame and is provided with V-slots at each of the corners, the rails being adapted to fit within these slots.

While the illustration shows an open-type machine, the design is such that if an enclosed motor is desired the armature supporting brackets may be removed and the ends of the frame finished so as to receive suitable enclosing heads, in the centre of which the armature bearings are arranged. The six-horse-power machine illustrated is designed for a minimum speed of 700 revolutions per minute, the maximum speed being 1,500 revolutions per minute, giving a total speed variation of 115 per cent at any speed between which limits the machine develops its full-rated horse-power with an efficiency of two per cent less at its maximum than at its minimum speed. This, the maker claims, justifies the statement that the motor may be operated at any imaginable speed within the limits of 115 per cent variation, the efficiency of the motor at a given load being practically independent of the speed at which it is operated. The construction of the pole-piece and plunger of the multipolar motor is similar to that used in the bipolar form, the field strength, consequently the armature speed, being varied in accordance with the position occupied by the pole-piece cores or plungers. When the plunger is adjusted so that its inner end comes in contact with the pole-shoe the magnetic circuit is most complete and of minimum reluctance, and, since the molecular magnetomotive force of the field coils remains constant, the volume of magnetic flux becomes a maximum and the speed minimum, or normal. As the plunger is being drawn away from contact with the pole-shoe a column of air is interposed which gradually increases the reluctance of the magnetic circuit as long as the plunger continues to be withdrawn. When the plunger reaches the limit of its outward motion the reluctance of the magnetic circuit, and hence the speed, becomes maximum.



NEW TYPE OF FOUR-POLE MULTI-SPEED MOTOR.

To those familiar with the action of field-regulated shunt motors of ordinary type a variation of speed of 115 per cent by a corresponding variation of the magnetic flux would seem impossible of realization on account of the difficulty of securing sparkless commutation when the field strength of the motor is so abnormally reduced. In the construction of the Stow multi-speed motor, however, the design of the pole-piece and plunger is such that as the volume of effective magnetism is diminished by the outward movement of the plunger, the remaining magnetic flux is forced more and more in the direction of the pole tips, thus furnishing a magnetic fringe of sufficient intensity to ensure sparkless commutation.

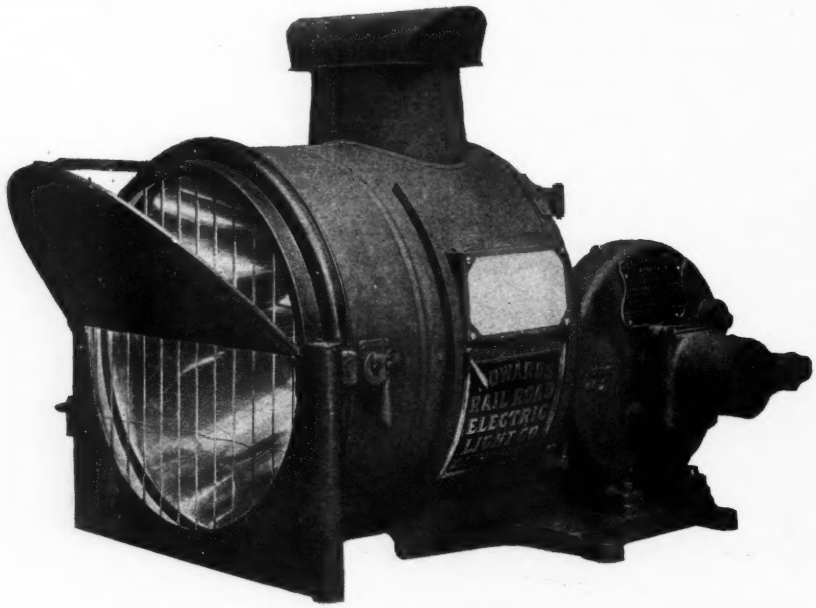
In regard to the fineness of speed adjustment, it is evident from the construction of the machine that there is no speed between maximum and minimum which can not be obtained by an appropriate adjustment of the hand-wheel. It should be understood that while the motor carries its full load sparklessly, at any imaginable speed within its range at practically maximum efficiency it will also carry any lesser load with a consumption of power corresponding with the actual work done. As the speed regulation is effected solely by varying the reluctance of the magnetic circuit, no controller or rheostat or resistance of any kind is used in the regulation of the speed, all electrical circuits and connections remaining unchanged through the entire range of speed.

The machine illustrated represents a type which is being built in sizes five horse-power to twenty-five horse-power. For sizes above twenty-five horse-power automatic means can be furnished for varying the speed. It is a fact worthy of emphasis that the special advantages offered by these motors are obtained without the sacrifice of any advantageous feature possessed by other machines of ordinary type, the efficiency being in every case fully up to the standard of first-class modern practice. The self-regulation of the machine is as close as motors of common form, this being due to the ample size of the armature conductors used in these machines. The temperature of the various parts of the machine, for open and enclosed type, comes well within the heat limit accepted as standard practice.

This machine is manufactured by the Stow Manufacturing Company, 136 Liberty street, New York city.

An Electric Locomotive Headlight.

The growing complexity and expansion of railway service of every kind and the consequently heavy duties which are imposed upon traffic managers, signal men and the workers on the train require that every precaution be taken to avoid accidents which occur every now and then through it not being observed that more than one train of cars are making use of a particular section of trackage at the same time. While many improvements have been made to switching and signaling apparatus proper, and means are being perfected by which a far-reaching shaft of light will be thrown from the cab headlight on to the track ahead, where there are curves or intervening obstructions in the way, a swift passenger train following a slow freight on parallel sidings could not be made aware of each other's proximity by a light which would show only directly in front. A peculiarity of the Edwards locomotive headlight equipment, manufactured by the Edwards Railroad Electric Light Company, of Cincinnati, Ohio, is that a bright beam of light is thrown upward in a vertical manner as well as to cover a considerable space in front of the approaching locomotive. This equipment consists essentially of a small steam turbine axially connected with a dynamo of suitable construction and designed to yield a current of thirty to thirty-five amperes at from thirty to thirty-three volts to an arc which throws its light from a specially constructed reflector.



ELECTRIC LOCOMOTIVE HEADLIGHT, SHOWING APPEARANCE OF ENTIRE HEADLIGHT UNIT.

The steam turbine is provided with a propeller wheel which is wholly constructed of rolled steel, the buckets thereon being die formed and so interlocked with the steel plates which form the body of the wheel as to withstand a very much higher speed than normal, it being claimed that this propeller wheel has a factor of safety of about seven, that is to say that while the normal speed of the engine and dynamo is about 2,000 revolutions per minute, the wheel will successfully withstand a speed of 14,000 revolutions per minute as proven by actual test. In this steam turbine the steam is allowed to expand down to nearly atmospheric pressure in the nozzle before it comes into contact with the wheel buckets. This results in throwing all, or nearly all, of the energy of the steam into effluent velocity, with the result that a very fair degree of steam economy is arrived at.

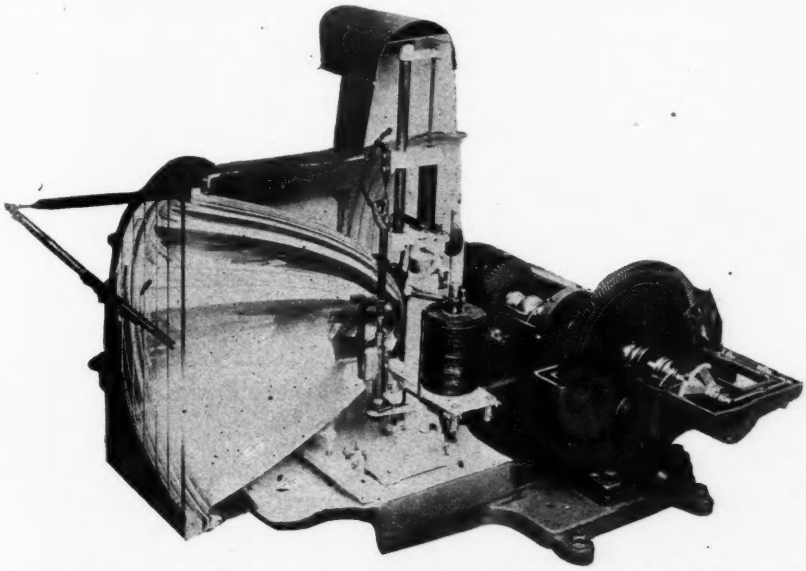
The speed of the engine is held constant, practically within about three per cent, regardless of load or initial pressure by a simple and efficient governor which is so arranged, with relation to the other parts of the engine, as to be easily and readily accessible should occasion demand. The wheel shaft is journaled in ball bearings, and there is no contact whatever of parts anywhere in the whole machine except at the ball bearings and the coefficient of friction is exceedingly small. Under actual test the engine will operate running to its full speed under a pressure so slight that a pointer upon a 180-pound steam speed gauge will not leave its stop, the gauge being connected at a point on the engine between the governor valve and the nozzle. All the moving parts are encased in a cast-iron housing so designed as to thoroughly protect it from the elements, dust, dirt, etc. The lubrication is wholly automatic and is provided by loose rings feeding the oil to the ball-bearings from the oil wells so as to require the least possible attention.

ELECTRIC LOCOMOTIVE HEADLIGHT, SHOWING METHOD OF MOUNTING AND DYNAMO AND TURBINE CONNECTION.

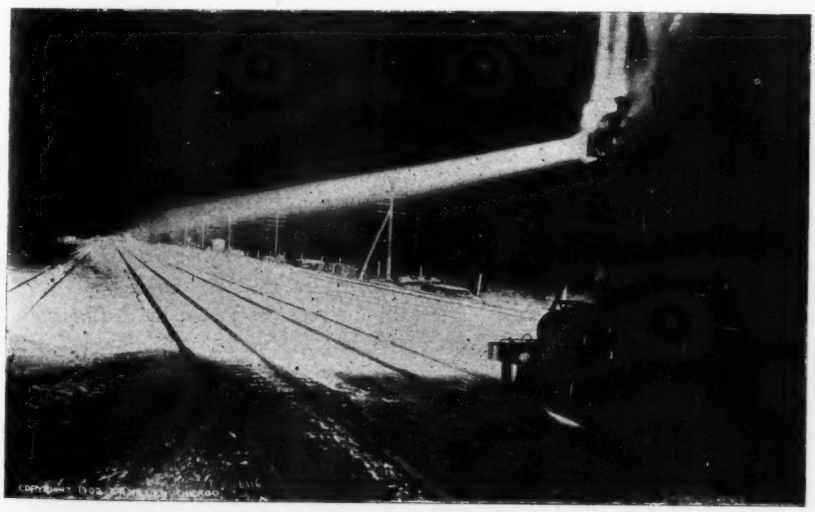
The dynamo is of peculiar construction, designed for the particular purpose for which it is used, and it is stated by the

manufacturer to be impossible to burn it out when operating under the trying conditions under which this machine is worked. The field is differentially wound and the electric circuits so arranged as that a burned-out armature is impossible. Should a short-circuit occur upon any point of the circuit the current is killed and no matter how long the engine may run or the armature rotate, there will be no production of current whatever until the short-circuit is removed. This done, the dynamo performs its proper functions and operates as usual. This is a factor of great value. The current densities throughout the whole machine are very low so that a minimum heat effect is produced regardless of extremes of temperature or other conditions which might affect the resistance of the machine. The electrical balance is so well adjusted that no spark or flash is ever perceived at the brushes. Very large and long journal bearings are provided and profuse lubrication is secured through the medium of loose rings dipping into oil wells.

Not the least valuable nor important feature of this equipment is involved in the lamp, which embraces within itself all the elements to produce a smooth and steady light in the most reliable way. It is very strongly and substantially made and has a record of many thousands of miles run without a waver or flicker.



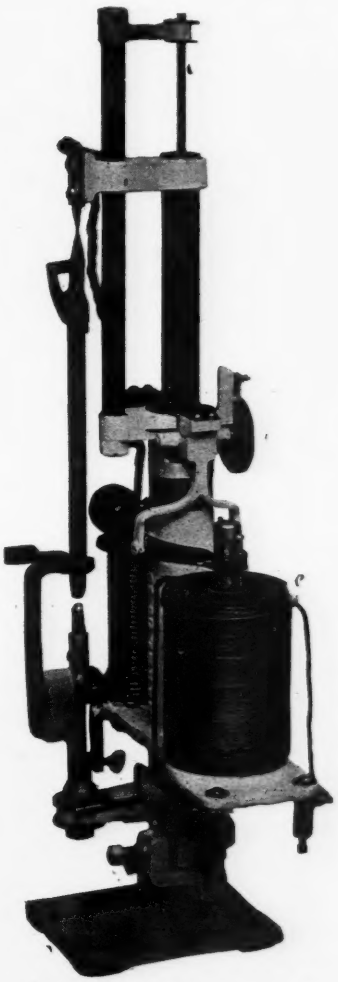
ELECTRIC LOCOMOTIVE HEADLIGHT, SHOWING IN DETAIL CONSTRUCTION AND APPLICATION OF MECHANISM.



ELECTRIC LOCOMOTIVE HEADLIGHT IN SERVICE, SHOWING VERTICAL BEAM. A NIGHT SCENE ON THE C. M. & ST. P. RAILWAY, SHOWING ONE MILE OF TRACK.

Perhaps one of the most startling and unique features of this equipment is the provision of an auxiliary plain deflector which is so arranged at an angle of forty-five degrees outside of the goggle, intercepting some forty per cent of the light issuing from the parabolic reflector and projecting it vertically. This forms a constant warning signal; the top of the vertical beam, upon cloudy nights, striking the clouds. This may be seen for many miles; in point of fact, upon the Chicago, Milwaukee & St. Paul road, it has been seen for a distance exceeding sixteen miles. This vertical beam may be seen regardless of hills or curves or any intervening obstacle whatever, and should make almost impossible head-on or rear-end collisions.

The horizontal beam is very powerful, showing clearly three-quarters of a mile to a mile ahead of the train bearing it, on a clear, straight track. Perhaps the only logical objection that was ever raised to an electric headlight is that fact that upon a double-track road there might be some tendency to blinding an approaching engineer. To guard against this contingency there is provided a translucent shade within the goggle which may be



ELECTRIC LOCOMOTIVE HEADLIGHT—A DETAIL ENGRAVING OF ARC LAMP USED.

drawn by the engineer having the light, when he may reach a point within a half a mile of an approaching engineer. This destroys the glaring effect of the light, giving it the effect of ground glass, and the shade is so held until the engineer shall have passed the approaching train when he releases his shade and at once gets the full value of the light. Low-resistance carbons are used and many months of constant use show a very slight wear or deterioration upon these brushes. This dynamo is wholly constructed in its essential magnetic parts of soft rolled steel, die formed, and the utmost care that the best modern electrical and mechanical engineering could demand is involved in its design and construction.

In Class A equipments the whole outfit is located upon one cast-iron bed-plate, and it is the work of only six to ten hours to apply the equipment to the locomotive, it being only necessary to secure the bed-plate at the proper place on the smoke arch by means of brackets bolted thereon, and the running of a three-quarter-inch live pipe from the cab and passing a one and one-quarter-inch exhaust pipe into the smoke arch. In Class B equipments the engine-dynamo combinations are located upon a separate bed-plate and the case upon another independent cast-iron base. This is to provide for those cases where it is advisable or desirable to locate the dynamo and engine at some other point upon the locomotive than the smoke arch.

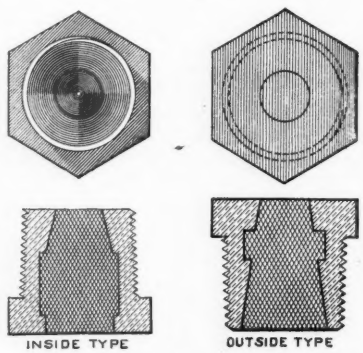
Fusible Boiler Plugs.

The recent action of the United States Treasury Department in enforcing the provisions of Section 4436 of the United States Revised Statutes, regarding the specifications as to the manufacture of fusible plugs, has attracted considerable attention to these articles.

Fusible plugs have been used in boilers for a great many years, and the government, recognizing the important function of this boiler accessory, requires that all plugs used on boilers of steam vessels should be made of bronze and have no other filling but pure Banca tin.

Many plugs have been offered on the market which are filled with fusible alloys composed of other metals which do not melt at as low a point as Banca tin. Since the disaster at Philadelphia last fall the United States steamboat inspection service of the Treasury Department has taken cognizance of the fact that inferior plugs were offered upon the market and issued a circular requiring that all fusible plugs should be filled with pure Banca tin and stamped with the manufacturer's name, and that an affidavit setting forth this fact should be filed with the inspector having charge of the boiler inspection at whatever point the plugs were used.

The Lunkenheimer Company, of Cincinnati, Ohio, has manufactured fusible plugs for a number of years, all of which



FUSIBLE BOILER PLUGS.

comply with these specifications, and, having made affidavit before the United States steamboat inspection service to the effect that its plugs comply with these requirements, the plugs are accepted by all inspectors throughout the United States.

The illustrations show two forms of plugs, namely, the outside and inside patterns, which are screwed in either from the inside of the boiler or from the outside through the fire-box or shell.

A New Marine Generating Set.

To meet the demand for a small and compact outfit, extreme lightness being especially desired, the marine generating set shown in the accompanying illustration has been manufactured by the Holtzer-Cabot Electric Company, of Boston, Mass. Aluminum is used very extensively in the construction in portions where great strength is not required. The dynamo is of the multipolar type, the ring and poles being of a grade of wrought iron selected on account of high permeability, and is reduced in weight to as great an extent as can be done without interfering with the efficiency of the machine.

A SMALL MARINE GENERATOR SET, MULTIPOLAR TYPE DYNAMO.

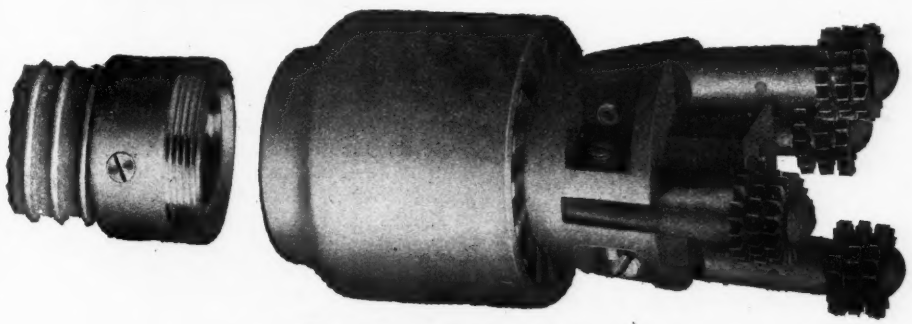
The armature is of the drum-wound type and well laminated, and is mounted upon the engine shaft. The brush-holders are of the radial type and self-oiling, and self-aligning bearings are used. All the working parts are completely enclosed and run in oil. The illustration shows the dynamo direct-coupled with a Herreshoff engine which has been designed especially for this class of work. It is of the sliding-valve type with throttle governor. The set shown weighs about 298 pounds and will supply thirty sixteen-candle-power lamps.

Soda and Bleach.

Commenting upon a paper by B. E. F. Rhodin upon the electrolytic manufacture of caustic soda and bleach manufactured at Sault Ste. Marie, Ontario, the *Electrical Times,* London, abstracts some interesting and valuable information. The water power is derived from a fall of nineteen feet in the St. Mary's River. In these works the mercury-cathode process is employed. A stoneware cylindrical vessel three feet in diameter, with radial openings at top and bottom, the upper ones closed air-tight by carbon blocks into which vertical carbon rods are screwed, is supported by a stoneware delivery pipe so as just to dip into a layer of mercury covered with water in a shallow cast-iron dish five feet in diameter forming the cathode. The interior is filled with brine and the dish with water, then the cylinder is rotated, when under a current of 800 to 1,000 amperes and five volts sodium amalgam is formed under the lower slots, and by the turbine action of radial flanges passes to the water in the outer annular space and yields caustic soda while the chlorine in the cylinder is collected by the delivery pipe. On losing the sodium the mercury sinks and returns to the centre of the bell from below, and the soda lye is drawn off on reaching the desired strength and replaced by water. The factory is worked under very careful analytical superintendence and has three 220-kilowatt dynamos, each separately driven with evaporation, bleach and lime plants, the latter producing fourteen tons of slaked lime daily. The loss of mercury at the cathode is very small, it being found that one pound of mercury is dissolved by the soda lye for every 27,500 pounds of caustic formed.

Water-Power Boiler-Tube Cleaner.

The accompanying illustration represents the Weinland improved No. 8 water-power boiler-tube cleaner, which is claimed to be a marked improvement in this line. The machine embodies the same general principles as other water-power ball-bearing cleaners made by this company. The improved machine, however, has been remodeled and has been made very much stronger than the other style. The spider to which the arms are attached is now almost solid, so that it will stand the severe strain put upon the arms. The bearings, including the balls, are larger, so that it runs with the least friction, and consequently is more durable. A new design of coupling is furnished with each machine. This coupling is an improvement over former designs used in this line. It holds the hose securely so that it will withstand any pressure which the hose will stand without any danger of pulling loose, as so frequently happens with the ordinary bands used in attaching hose.



WATER-POWER BOILER-TUBE CLEANER.

The Lagonda Manufacturing Company, of Springfield, Ohio, the manufacturer of this apparatus, will gladly write any one who may be interested, giving them full particulars, etc., of this new cleaner or of the other styles which it makes. It also continues to make the former No. 1 Weinland water-power ball-bearing machine which is so well known to the users of tube cleaners through their appearance in this and other numbers of this journal.

The Gould Storage Battery.

The plate of this battery is of the Planté type, in the manufacture of which the spinning principle is used, giving the greatest obtainable increased service and possibilities of modification of form. Sheet-lead blanks placed in steel frames reciprocate between two rapidly revolving shafts on which are mounted alternating steel discs and spacing washers. No lead is removed during the spinning, the blank being merely changed in form as the cylinder disc spins up a rib on either side, and the spacing washer gauges the width of this rib. The plates are subdivided into sections varying in number and size according to the total dimensions of the plates.

The essential point is the provision in the Gould battery by the cross-bars of unspun lead giving lateral strength, and the rib which forms a bridge construction together with the unspun vertical portions between the sections supplying vertical strength. Chemical lead is used in the Gould plate as it has the property of a greater resistance to the disintegrating action of the acid, the lead used being of the densest form of rolled lead obtainable, and the action of the knives in the spinning or upsetting of the lead renders it even more dense than that of the original blank.

The width of the grooves is governed by the kind of work which the plate has to perform, varying from 0.005 to 0.024 of an inch. These grooves are given a formation which fills them with closely packed but porous active material. When the grooves are filled the active material and the ribs are in such contact that mechanical displacement or falling out of the active material is impossible. This intimate combination is so perfect that the whole forms a consolidated mass of active material ramified by numerous conductors assuring the continuance of the initial structure of the plate up to the extreme limits of usefulness.

The construction is such that the internal resistance is extremely low and all of the characteristics which tend to lower the external resistance have been brought to the highest state of perfection.

An Improved Spinning Jenny.

The spinning jenny shown in the accompanying illustration is manufactured by James S. Barron & Company, 200-206 West Broadway, New York city, and is being made for telephone companies in two sizes, eighteen and twenty-four inches long, both lengths having an inside diameter of two inches.

These spinning jennys, while not new, are again coming to the front, it is claimed, by the manufacturers as one of the most practical tools for elevating and binding cables to support wires, the operation being extremely simple. The jenny consists of two parts which enables it to be placed in position inserting the cable and support wire at any point on the line. The two sides are provided with dowel lockings and are copper lined to prevent injury to the cable. The marline for binding purposes is wound around the jenny in one or more layers as required, the outer end of which is fastened at the place of starting. The rear end is beveled so as to allow the marline to play off smoothly. The cable to be bound is elevated from a snatch-block hung on the support wire just ahead of the jenny, and the binding is done by the spinning off of the marline as the apparatus is hauled along by means of the rope fastened to the iron arm.

AN IMPROVED SPINNING JENNY.

The Telephone Situation at Baltimore.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

There have recently been some interesting developments in the telephone situation at Baltimore, and since the facts have been frankly put before the public by President Edward H. Bouton, of the Maryland Telephone and Telegraph Company, there is material for a short review of an interesting situation. The Maryland Telephone and Telegraph Company began opposition to the Chesapeake & Potomac Telephone Company a few years ago, and now has nearly 7,000 stations in Baltimore. To obtain a franchise the company promised a good service at low rates, and agreed with the city to charge not exceeding $48 a year for business service, and $36 a year for residence service. This agreement was made part of the franchise, and the Maryland company, in advertising its service at the low rates named, adopted as its slogan to attract

patronage the phrase, "Talk as much as you please."

Mr. Bouton, soon after accepting the presidency of the company, discovered that talking as much as you please for $48 a year in a city the size of Baltimore does not pay the telephone company. Mr. Bouton has made a long argument advocating the passage of an ordinance which will permit the Maryland company to adopt message rates. He states that the company has spent over $2,000,000 in its Baltimore plant, which gives an average cost per station of about $300. This figure does not include subway ducts which are rented from the city. The operating expenses of the system, while not given in figures, are stated by Mr. Bouton to be more than twice as high as in the company's exchanges in smaller towns. This difference Mr. Bouton attributes wholly to the large traffic originated by his Baltimore subscribers. He finds the traffic increases in much greater ratio than the number of subscribers, and now averages fifteen calls per day per telephone, a high figure, but undoubtedly not, as Mr. Bouton claims, higher than the average traffic of any other system of equal size in the country. Mr. Bouton says that his large traffic is due to the fact that as he operates under flat rates, and the Bell company under message rates, the telephone subscriber in Baltimore uses his Bell telephone sparingly and sends the greater part of his traffic over the Maryland system.

Mr. Bouton frankly admits that he is on the horns of a dilemma. He states that the alternatives that confront him are to adopt message rates and so to charge the large users much more than he charges them at present, or to cease developing the business and abolish his cheaper rates. In either case he has the public to reckon with, as to obtain the right by ordinance to raise rates is one thing, while to get the public to accept an increase without angry protest is quite another.

The experience of the Maryland company is about what has been forecast by many observers, both in and out of independent ranks, as the inevitable result of attempting to operate a telephone system in a large city at flat rates suitable only for a very small place. The outcome of the Baltimore situation will be watched with interest by all telephone men, and especially by those interested in telephone securities. M. W. H.

Baltimore, May 8.

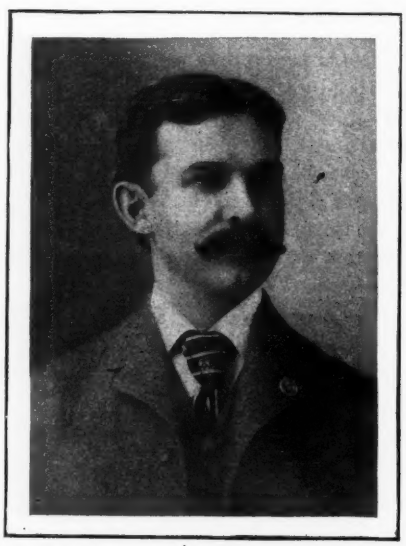
A nickel-steel alloy with thirty-six per cent nickel has the lowest temperature coefficient known.

The Convention of the National Electric Light Association.

From the latest reports it may be gathered that in importance and interest the twenty-fifth convention of the National Electric Light Association, which will be held in Cincinnati, Ohio, May 20, 21 and 22, will be a notable one in addition to the list of meetings held already.

The number of enquiries for transportation and the questions deposited in the "Question Box" assure the executive officers of a very successful gathering as regards numbers and variety of topics.

The local reception committee has arranged a series of events which will do much to make the occasion a memorable one. Special attention will be given to the ladies in attendance and a large number are expected. A visit for the ladies to Rookwood Pottery and the Cincinnati Museum of Fine Arts has been arranged. They will also be tendered a trolley ride through the city and suburbs to the Zoological Gardens, where lunch will be served. A visit to include all the delegates has been arranged by the Bullock Electric Manufacturing Company, which will throw open its works for inspection.



HENRY L. DOHERTY, PRESIDENT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The railroads are cooperating with the various committees to advance the availability of the convention location. Besides the Grand Hotel, which has been selected as headquarters for the convention, other houses, notably the Gibson House and the St. Nicholas Hotel, are making preparations for the accommodation of guests.

The present officers of the National Electric Light Association are:

Henry L. Doherty, president, Denver, Col.

Louis A. Ferguson, first vice-president, Chicago, Ill.

Charles B. Hunt, second vice-president, London, Ontario.

George F. Porter, secretary and treasurer, New York.

C. O. Baker, Jr., master of transportation, New York.

Executive committee—E. F. Peck, William M. Brock, Chas. E. Scott, Dudley Farrand, E. L. Bemiss, Ernest H. Davis, Chas. L. Edgar, C. C. Howell, D. P. Robinson.

The following topics will be presented for discussion:

"Rates"—Henry L. Doherty, Denver; L. A. Ferguson, Chicago; Alex. Dow, Detroit; L. R. Wallis, Woburn, Mass.; Ralph J. Patterson, Waterville, Me.; Samuel Scovil, Cleveland, Ohio.

"Signs and Decorative Lighting"—Papers by Russel Spaulding, of New York, and E. J. McAllister, of Newark, N. J.

"Are Free Lamp Renewals Desirable?"—James English, New Haven, Ct.; F. Ellwood Smith, Somerville, Mass.; F. W. Little, Peoria, Ill.; W. J. Greene, Cedar Rapids, Iowa.

"What Efficiency Lamp Should Be Used?"—Henry L. Doherty; Samuel E. Doane, Marlborough, Mass.; L. G. Van Ness, Denver; Francis W. Willcox, Harrison, N. J.

"What Improvement Is Desired in Meters?"—Robert Ferris, Monmouth, Ill.; C. A. White, Somerville, Mass.; H. H. Scott, Lincoln, Neb.

"Are Loose-Leaf Ledgers Desirable for Electric Companies' Records?"—G. E. Tripp, Boston; H. H. Fairbanks, Worcester, Mass.; George W. Davenport, Boston; Charles R. Price, New Bedford, Mass.

"The Advantages of Gas Engines"—Charles H. Williams, Madison, Wis.

"What Changes Should Be Made in the Plan of Uniform Accounting?"—J. P. Crowley, St. Paul, Minn.

Caring for Consumers' Complaints"—Irvin Butterworth, Denver.

"Boiler Firing with Oil"—James W. Warren, Los Angeles, Cal.; H. T. Edgar, El Paso, Tex.

"Three-Phase *vs.* Two-Phase for City Distribution"—B. A. Behrend, Cincinnati; Charles F. Scott, Pittsburg.

"Hot Water *vs.* Steam Heating"—J. F. Porter, Alton, Ill.; P. H. Korst, Janesville, Wis.; C. R. Maunsell, Topeka, Kan.

"Does It Pay to Treat Poles with Creosote, Oil or Other Compounds?"—W. F. Moore, Augusta, Ga.

"Gas Explosions in Underground Systems"—James Blake Cahoon, New York.

"Protection of Long-Distance Transmission Lines"—F. A. C. Perrine, Pittsfield, Mass.; L. Denis, Quebec; P. N. Nunn, Provo, Utah; P. M. Lincoln, Niagara Falls, N. Y.; H. J. Gille, St. Paul, Minn.

"Present Performance of the 220-Volt Lamp"—Fred W. C. Bailey, Columbus, Ohio.

"Report of Committee on Photometric Values of Arc Lamps"—Henry L. Doherty, chairman.

Question box.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

SECRETARY NATIONAL ELECTRIC LIGHT ASSOCIATION—Mr. George F. Porter, former secretary of the National Electric Light Association, has resigned, and Mr. J. B. Cahoon, ex-president of the association, has been appointed secretary. Mr. Porter was compelled to leave for Alaska on important business on Thursday of this week, and as the convention of the association is to be held in Cincinnati next week, Mr. Cahoon accepted the position until a new secretary can be elected.

AMERICAN CAPITAL IN MEXICO—A statement has been compiled in Monterey, Mexico, showing that $200,000,000 of American money has been invested in mining and industrial enterprises in northern Mexico during the last two years. These figures do not represent the value of stock of companies, but is the actual money that has been invested. According to this statement American capital is still coming in to northern Mexico at the rate of about $100,000,000 a year.

TELEPHONE MANUFACTURERS' ASSOCIATION OF THE UNITED STATES—This association was formed at Chicago last week and elected officers as follows for the ensuing year: President, A. Stromberg, of Stromberg-Carlson Telephone Manufacturing Company; vice-president, K. B. Miller, of Kellogg Switchboard and Supply Company; secretary, J. E. Keelyn, of Keelyn Telephone Manufacturing Company; treasurer, V. H. Messenger, of Advance Electric and Telephone Company. Board of directors—Frank G. Jones, of American Electric Fuse Company; H. E. Procunier, of Moon Manufacturing Company; Arthur Stein, of Eureka Electric Company; L. G. Bowman, of Western Telephone Construction Company; C. W. Farr, of Farr Telephone and Construction Supply Company; H. H. Hipwell, of Hipwell Manufacturing Company; C. E. North, of North Electric Company. Executive committee—Frank G. Jones, chairman; H. E. Procunier, L. G. Bowman, H. H. Hipwell and J. E. Keelyn, secretary. Regular meetings are to be held monthly, and the membership includes manufacturers of independent telephone apparatus who have been in business one year or more.

A LARGE TRACTION MERGER—It has been announced that a $5,000,000 traction company has been launched at Hamilton, Ohio. The new company will be known as the Cincinnati, Dayton & Toledo Traction Company and will open a trolley line from Toledo to Cincinnati. Under the terms of the merger the Southern Ohio will get $2,000,000 of the new stock in return for its present $2,000,000 stock, and in addition $1,200,000 in bonds. The Cincinnati & Northwestern will get $1,000,000 of the new stock, and the remaining $2,000,000 will be used to extend the road and purchase new properties. The Western Ohio Railway Company is now being extended from Dayton to Findlay from where a traffic arrangement is to be made to Toledo. This, it is understood, will be over the Toledo, Bowling Green & Southern Traction Company in which Cincinnati capitalists are interested. The controlling interest in the Southern Ohio, Cincinnati & Northwestern and Western Ohio Railway is the Mandlebaum-Pomeroy combination which is also in control of the Miami & Erie Canal Transportation Company. Two bills are before the legislature and it is believed that they will be very much to the advantage of the syndicate if favorably considered. One is to allow the merger of the Cincinnati & Northwestern with the Ohio Southern and the other the Painter Canal bill, authorizing the lease of the canal bank to traction companies.

THE POSTPONEMENT OF THE LOUISIANA PURCHASE EXPOSITION—Fifty-one directors of the World's Fair have signed a joint telegram to President Thomas H. Carter, of the National Commission, assenting to the postponement of the exposition to May 1, 1904. This action was taken after the executive committee had authorized President Francis to draft a postponement despatch. A statement has been given out by President David R. Francis, of the Louisiana Purchase Exposition Company, to the effect that the sundry civil bill which passed the House several weeks ago, and is now going through the Senate, contains an appropriation of $1,048,000 to provide for a government exhibit and special Indian exhibit, and the additional cost of the government building. It was deemed advisable to have the date of the fair definitely fixed in that bill, but in that event any change from 1903 should be immediately decided upon. For many months past the fair has virtually been postponed for one year, a decided majority of the directors preferring 1904. The repeated request of both foreign and domestic exhibitors for a postponement, and advices from the foreign governments to the effect that they did not have sufficient time in which to make preparation for a representative exhibit in 1903, the statement that the Philippines would not be able to install their exhibits in a creditable manner if the exposition should not be postponed until 1904, the expressed fear of the government architect that he could not procure material for a government building by 1903, and the fact that the general public for many months past considered a postponement a foregone conclusion are some of the reasons that moved the executive committee to authorize the forming of the national commission that any action of Congress changing the time of the exposition from 1903 to 1904 would be acceptable. It is believed that proper steps will be taken offering an amendment to the bill involved and providing that the dedication ceremonies shall be held not later than April 30, 1903, and that the exposition shall be opened to the public on or before May 1, 1904, and be closed December 1, 1904, and continue the existence of the exposition committee, which is composed of former congressmen, until January 1, 1906.

ELECTRIC LIGHTING

CANANDAIGUA, N. Y.—The board of light commissioners is investigating the advisability of establishing municipal lighting. It is estimated that a plant with a capacity sufficient to furnish lights could be established for about $45,000.

MONTGOMERY, ALA.—The city council has awarded the contract for lighting the city to the Montgomery Light and Power Company. The company is to furnish not less than 225 arc lights at $51 each a year, and not less than 250 incandescent lamps at 75 cents per month each.

SAN JOSE, CAL.—The United Gas and Electric Company, recently incorporated in San Francisco, with a capital stock of $2,500,000, has secured a definite option of both the electric light and power companies of this city, and the expectation is that the deal will be closed in a short time.

MILWAUKEE, WIS.—The common council has passed a resolution favoring the erection of a municipal electric lighting plant on Jones Island, as near to the garbage disposal plant as it is practical to build it. The resolution directs the city engineer to prepare an estimate of the cost of such a plant and submit it to the council within thirty days. The plant will have a capacity of 2,500 arc lights, each of 2,000 candle-power. The resolution did not carry with it any appropriation, but an ordinance to issue $100,000 of bonds for the purpose of building the plant is now pending.

YORK, PA.—The York Haven Power Company, which has the electric plant under way at York Haven, has transferred a portion of its activities to York and is now making arrangements for the introduction of power here later on, by the construction of a transforming station in this city. It is the intention of the power company to extend its wires over the whole city, but it will in no way compete with the Merchants' or Edison companies for furnishing electricity for lighting purposes. Only electrical power for the running of motors and other electrical appliances in the local factories will be provided.

GREENFIELD, MASS.—The stockholders of the Greenfield Electric Light and Power Company have voted to ask for permission to increase their stock from $30,000 to $100,000, and are ready to receive subscriptions for new stock, present stockholders having the first chance, but with so large an increase it is not probable that they will take it all. The plans of the company are not fully completed, but it has been decided to build a dam of concrete, thirty-five feet high, on which flashboards two feet high can be placed, giving a fall of thirty-seven feet. The plan is to put in two generators, each directly connected onto the shaft of a pair of horizontal water-wheels, with sufficient power to generate from 1,000 to 1,200 horse-power, which is about four times the amount used. The cost of the new plant is estimated at $100,000, in addition to present investment.

ELECTRIC RAILWAYS

IRVINGTON, ORE.—A petition will be sought by the Portland Railway Company to get a route to connect with its Union Avenue and Burnside track as soon as plans for the route is decided upon.

NORTH YAKIMA, ORE.—A plan has been proposed to construct an electric line through the Yakima Valley. It is expected that the farmers will contribute considerable freight business and that the enterprise will be a profitable one.

SPARTA, WIS.—Capitalists have obtained a franchise from the city council to construct an electric railway. They also propose to extend the line to Melrose, Jackson County, touching the towns of Cataract and Burr Oak. The line will be about twenty-five miles in length and will tap the most fertile portion of Jackson County.

MANISTEE, MICH.—It has been reported that the entire street railway system here is soon to change hands. The Manistee, Filer City & Eastlake Railway Company operates seventeen miles of single track around the shore of Manistee Lake, from Filer City on the south, through Manistee to Eastlake, with a spur to Orchard Beach. George A. G. Hart is president, treasurer and general manager of the system. It is said that it is the purpose of a number of Chicago capitalists to purchase the system.

SLATINGTON, PA.—The remaining link of twelve miles of the Lehigh Valley Traction line between North Wales and Chestnut Hill is likely to be finished by June. This will make feasible a continuous trolley ride from Philadelphia to Slatington, a distance of 76 miles. The ride will require about four hours. The Lehigh Valley Company has completed the work of changing the gauge of its tracks from Quakertown to Perkasie. Within a few weeks the process will be extended southward through Lansdale.

CAPE BRETON, NOVA SCOTIA—The Cape Breton Electric Company expects to have the cars running on its Sydney tramway in July. It is now distributing poles along the route and next week will commence the work of laying the rails. It will start at several different points and the work will proceed very rapidly. The only delay anticipated is in the filling of some of the contracts for machinery. The power-house building, near the S. and L. trestle, is already about half completed. The steel rafters forming the roof having been put in position recently.

WILLIMANTIC, CT.—Engineers are in this city getting ready to begin the survey of the proposed trolley line between this city and Southbridge, Mass. The promoter of the road is a Mr. Metcalf, who says that the $50,000 of capital stock has been nearly all subscribed and that Boston capitalists are ready to finance the road. He claims to have nearly one-half the necessary rails all ready to lay and two water powers in the vicinity of Eastford which will furnish the power to operate the line. He says that the work of surveying the line will take nearly six weeks, but it is promised that the work of construction will begin by June 1.

TELEPHONE AND TELEGRAPH

ELLENVILLE, N. Y.—Herman S. Wells, of Ellenville, has bought the stock of the Delaware River Telephone Company which owns the local system in this county. It is said that the lines will be equipped with long-distance instruments.

PHILADELPHIA, PA.—The shareholders of stock in the Bell Telephone Company at a recent meeting authorized the issue of 80,000 new shares of a par value of $50 each, bringing the total capitalization up to $12,000,000. The additional stock, it has been stated, is for the legitimate increase of business.

WARRENTON, VA.—The new Baltimore Telephone Company has completed its line to Warrenton connecting this city with the entire upper end of Prince William County. Connections can now be made as far north as Manassas, and at Haymarket communication can be had with the long-distance telephone to Alexandria.

BALTIMORE, MD.—The Maryland Telephone and Telegraph Company has had introduced in the city council here an ordinance which, among other things, releases the company from a provision in its present charter and agreement with the city whereby it is now prohibited from charging more than $48 per year for a business telephone and $36 per year for a residence telephone.

BUFFALO, N. Y.—The contract for building a system of conduits through thirty miles of local streets has been awarded by the Frontier Telephone Company to the German Rock Asphalt Cement Company. The expenditure involved will amount to about $400,000. It is the intention of the Frontier company to disturb the principal streets of the city as little as possible in order that the work may proceed with greater rapidity. It has been stated that the new telephone system will be in working order by November 15, and that the work of constructing the big underground conduit system will be in progress at once.

OBITUARY NOTICES

DAVID R. WALKER, ex-chief of the City Electrical Bureau, died suddenly of apoplexy on May 8 at his home in Philadelphia. He was about seventy years of age. Chief Walker resigned a year ago after having been for twenty-five years at the head of the Electrical Bureau. Many improvements in the city fire and police signal system were made during his incumbency.

MR. JOHN H. EMERICK, of Brooklyn, died Sunday morning, May 11. For many years Mr. Emerick was superintendent of fire-alarm telegraph in New York city, and during recent years was superintendent of the Postal Telegraph Company in New York, retiring from that service about two years ago. Mr. Emerick was an old United States military telegraph operator, serving under General Thomas T. Eckert during the Civil War. His death resulted from a complication of liver and kidney trouble.

MR. FRANK R. COLVIN, formerly business manager of the *Electrical Engineer*, and during recent years connected with the Western Electric Company, died very suddenly of heart disease at his home in Roselle, N. J., on Friday, May 9. Mr. Colvin was quite well known in electrical circles and was a graduate of the Naval Academy at Annapolis, class of 1883. Since his retirement from newspaper work, Mr. Colvin was quite active in the telephone field, representing the Western Electric and Bell interests. The funeral which was held at Roselle on Monday of this week was private, only a few of his intimate personal and professional friends being present.

PRESIDENT HENRY MORTON, of the Stevens Institute of Technology in Hoboken, died at the private hospital of Dr. John B. Walker in New York city at ten o'clock on the night of Friday, May 9. An operation which it was thought would be very successful was performed on April 15, the patient gaining steadily for ten days. However, he suffered a relapse and continuing to grow weaker, sank slowly Friday night. President Morton was born in Hoboken, December 11, 1836. He was a son of the Rev. Henry J. Morton, who was for fifty-six years rector of St. James Episcopal Church in Philadelphia. He was graduated from the University of Pennsylvania in 1857, and after studying law abandoned the idea of practising it and devoted himself to the study of chemistry, physics and mechanics. In 1863 he was elected professor of chemistry in the Philadelphia Dental College, and in 1869 the new chair of chemistry was created for him at the University of Pennsylvania. In the same year he took part in the expedition sent out by the United States Nautical Almanac Office to observe the total eclipse of the sun, and in connection with these observations was the first to prove the true nature of the bright line on the sun's disc adjacent to the edge of the moon which is seen in partial-eclipse photographs. Professor Morton was appointed president of the Stevens Institute in 1870, and he entered upon the task of making the institution the first school whose exclusive object was to teach mechanical engineering as a profession. In 1880 he presented the trustees with a $10,000 workshop, this with his subsequent gifts to the institute aggregating more than $15,000. In 1878 President Morton received an appointment to the United States Lighthouse Board from Secretary of State Sherman. In the capacity of chairman of the committee on scientific tests the new appointee conducted numerous tests on fog signals, illuminated buoys, fire extinguishers and electric lights. He was the first to make a thorough investigation of the Edison incandescent lamp and announce its great value. During recent years he contributed articles on electricity and fluorescence to most of the prominent scientific journals. In 1873 he was elected a member of the National Academy. In June, 1897, he received the degree of doctor of science from his alma mater and doctor of laws from Princeton University. Besides his scientific work he contributed many articles to contemporary literature, one well-known poem being "The Hand that Rocks the Cradle Rules the World," which was dedicated to Mrs. Andrew Carnegie. This is generally believed to have induced Mr. Carnegie to present to Stevens Institute the laboratory which bears his name.

ELECTRICAL SECURITIES

A very evident result of the conditions which have been unveiled during the last two weeks in Wall street conditions is the almost entire absence of public speculative interest in the stock market and that movements are due entirely to the manipulations of strong professional bidders. At the close of the week professional sentiment is distinctly on the decline and a further general sagging of prices is believed to be due during the coming week. The coal mining situation appears now to to have taken an adverse turn, but reports are to the effect that the miners are not unanimous in preparing to obey a preliminary strike order. Just what will be the outcome of the coal strike is at this time uncertain. It is significant, however, that among financiers and bankers close to the anthracite owners the belief is general that any strike will be short-lived. The general prosperity of this country has been so uniformly good, trade has been so active in all directions, money has been plentiful, and the absence of disturbing legislation and political discussions have been so beneficial that in the main values are higher than those that prevailed at this time last year.

ELECTRICAL SECURITIES FOR WEEK ENDING MAY 10.

New York:	Closing.
Brooklyn R. T.	65⅞
Con. Gas	226½
Gen. Elec	321
Kings Co. Elec	200
Man. El	131⅞
Met. St. Ry	149
N. Y. & N. J. Tel. Co	175
Westinghouse Mfg. Co	219½

Boston:	Closing.
Am. Telep. & Tel	181½
Edison Elec	281
Mass. Elec. pf	97
New England Tel	148
Western Telephone & Telegraph	102

American Telephone and Telegraph, Edison, and Western Telephone and Telegraph all made significant gains during the week.

Philadelphia:	Closing.
Elec. Co. of America	7⅛
Elec. Stor. Bat. c	88
Elec. Stor. Bat. pf	87
Philadelphia Elec	5½
Union Traction	43½
United G. I. Co	122

Mr. Thomas Dolan has resigned from the board of directors of Union Traction of Philadelphia. The stockholders of the United Gas Improvement Company voted to increase the capital stock of the company from $22,500,000 to $28,250,000. The allotment will be made in the proportion of one share of the old stock for four shares of the new. There will be issued 115,000 shares of the par value of $50.

Chicago:	Closing.
Chicago Edison Light	171
Chicago Telep	170
Metropolitan El. pf	90½
National Carbon	25¼
National Carbon pf	91¼
Union Traction	20½
Union Traction pf	51

Earnings of the Union Traction Company are said to have increased in the neighborhood of $1,800 a day during April, compared with same month last year.

PERSONAL MENTION

MR. A. J. DE CAMP, of Philadelphia, largely interested in the electric lighting of his city and one of the pioneer electric light men of the country, was a New York visitor last week.

MR. H. H. HUBBARD, treasurer of the Eastern Electric Company, of Lynn, Mass., was a New York visitor this week, calling upon many of his friends in the electrical fraternity of this city.

MR. EUGENE F. PHILLIPS, of Providence, R. I., is receiving the condolence of his many friends over the recent severe loss by fire at his residence. While his fine home was not entirely destroyed, it was badly damaged before the fire was got under control.

MR. F. C. PHILLIPS, president of the Elwell-Parker Electric Company, of Cleveland, Ohio, spent several days in New York last week. Mr. Phillips is an enthusiastic Clevelandite and states that the various manufacturing interests of his growing city are running at full capacity.

MR. CALVIN W. RICE, the well-known electrical engineer, formerly with the New York Edison Company, will hereafter be identified with the Westinghouse interests as second vice-president of the Nernst Lamp Company, and will make his headquarters in both New York and Pittsburg.

MR. CHARLES L. EDGAR, president of the Edison Electric Illuminating Company of Boston, was a visitor in this city last week. Mr. Edgar has the honor of being at the head of one of the most prosperous electric light companies in the world, and reports a constant growth of the business of his company.

COLONEL ROBERT C. CLOWRY, president of the Western Union Telegraph Company, is now actively in charge of his vast organization, and is making a number of changes looking to the betterment and increase of the service. Colonel Clowry and family are residing at present at the Holland House, in this city.

MR. DAVID SHANKS, of Handley & Shanks, general electrical engineers, Birmingham, England, will be in New York next week, stopping at the Waldorf-Astoria, where he will be pleased to make appointments with those who are desirous of coming in touch with conditions as they now appear in Great Britain.

MR. EDWARD C. DE WOLFE, late in charge of the drafting room of the Dodge Manufacturing Company, of Mishawaka, Ind., and a frequent contributor to the columns of various mechanical journals, has accepted a position as associate editor of *Steam Engineering*, which has lately removed from New York to Chicago. He takes up his new duties at once.

MR. U. N. BETHELL, general manager of the New York Telephone Company, was elected first vice-president and a member of the board of directors of the same company at the general meeting last week. Mr. Bethell still retains the presidency of the Chesapeake & Potomac Telephone Company and his active connection with other important telephone enterprises.

MR. IRA H. MCCORMACK has resigned as general manager of the Cleveland Electric Railway, and has accepted a position with the New York Central Railroad as assistant general manager of the Harlem division, in charge of the tunnel and New York city terminals. He will be succeeded by Mr. John J. Stanley who is now vice-president and general manager of the Utica, N. Y., lines.

MR. CHARLES EVELBAUER, who has been in America five months studying the automatic telephone system of the Automatic Electric Company, of Chicago, has completed his work and returned to Germany on May 15, where he will take charge of the large factory which has just been built by the Deutsche Waffen and Munitions Fabriken for the purpose of manufacturing automatic telephones for the German Government.

MR. JAMES F. CUMMINGS, manager of the British electrical engineering and contracting firm of Maguire & Baucus, which firm represents the British interests of the European Maguire Manufacturing Company, Limited, the Aultman & Taylor Machinery Company, of Mansfield, Ohio, builders of the Cahill boilers, and other American manufacturing concerns, is now on a visit to the United States, stopping at the Hotel Imperial, New York city.

MR. ANTHONY N. BRADY, at a recent meeting of the board of directors of the Brooklyn Rapid Transit Company, raised $20,000 for Adelphi Academy, of Brooklyn, as the personal contribution of himself and other members. Mr. John D. Rockefeller had made a large contribution to this institution of learning, in which Lieutenant-Governor Timothy L. Woodruff is largely interested, with the understanding that as much more was to be donated by others. Mr. Brady's generous gift completed the sum necessary.

DR. A. E. KENNELLY has been appointed professor of electrical engineering at Harvard University. For many years Dr. Kennelly has been well known as an electrical engineer of great originality and ability, his writings, especially those dealing with the analytical side of electrical physics and engineering, having attracted respectful attention throughout the world. Dr. Kennelly is of English parentage and was born in Bombay, India. After some years of experience as an engineer of one of the large British cable telegraph companies, he came to this country and was early associated with Mr. Edison in the Llewellyn Park works. In association with Professor E. J. Houston he has for some years carried on the practice of electrical engineering as a designer and consultant. He was president of the American Institute of Electrical Engineers from 1898 to 1900 and left behind an enviable record as a dignified, efficient and capable president. He is one of the best impromptu speakers in the profession. Harvard University is to be congratulated upon its acquisition of Professor Kennelly, under whose administration the school of electrical engineering will doubtless prove one of the most valuable branches of that institution.

INDUSTRIAL ITEMS

THE ELECTRIC GAS LIGHTING COMPANY, Boston, Mass., states that its sales of the "Howes" swiveling attachment plug is very rapidly increasing.

M. B. AUSTIN & COMPANY, Chicago, Ill., will be pleased to send information regarding their ready pay-out reels for telephone, electric light, street railway and all line construction work.

THE ELECTRICAL EQUIPMENT COMPANY, 939 Monadnock Block, Chicago, Ill., and C. A. Cotton, 394 Atlantic avenue, Boston, Mass., have been added to the list of agencies of the Warren Electric Manufacturing Company, Sandusky, Ohio.

FRICK & LINDSAY COMPANY has removed its headquarters to Nos. 109 and 111 Wood street, Pittsburg, Pa., where it has increased its facilities and where it will be provided with a more complete stock, promising additional means to fill orders promptly.

THE STANLEY ELECTRIC MANUFACTURING COMPANY has moved its New York office from 71 Broadway to 29 Broadway. The growth of the New York office has demanded increased facilities and greater accommodations. Mr. M. D. Barr is the manager of sales.

THE GOULD STORAGE BATTERY COMPANY, New York city, has secured the order for the Berlin & Waterloo Street Railway Company, Berlin, Ontario, consisting of 255 cells, with a 66-kilowatt capacity and allowance for fifty per cent increase, regulating booster and switchboard.

THE ASHTON VALVE COMPANY, New York city, has removed its New York store to 110 Liberty street, where, with larger and better quarters, it will be able to promptly serve the trade with its line of high-grade safety valves and vacuum gauges. Mr. Charles H. Buckelew is the New York manager.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has recently issued to the trade an attractive folder on Westinghouse lightning arresters. It contains an excellent description of the new Westinghouse low equivalent arrester, which has been received with such general favor.

THE FALLER AUTOMATIC TELEPHONE EXCHANGE COMPANY, New York, has removed its offices and show-room to No. 22 Union Square East, where it will exhibit the Faller automatic telephone operator and where it will also have its factory for preparing standard and patterns, dies and special tools for the manufacture of the machine.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, manufacturer of "Sterling Special," "Sterling Regular" and "Phœnix" incandescent lamps, has issued a very complete catalogue including descriptions and half-tone illustrations, together with a telegraphic code for ordering. Mr. Francis Granger is the manager of the New York office at 26 Cortlandt street.

THE KEMMERER ELECTRIC LIGHT SHIFTER COMPANY, Weissport, Pa., manufactures an ingenious device which will prove very desirable for dentists, draftsmen, doctors, or any operator who needs a light that he can place anywhere he wants and in any position. This shifter has an almost indefinite range of positions and is becoming very popular in this class of service.

THE CONSOLIDATED RAILWAY ELECTRIC LIGHTING AND EQUIPMENT COMPANY, New York city, is installing its "axle-light" system of electric lighting for the Pennsylvania Railroad on all of the limited train service. It is stated that there will be greater economy in the new system than in the old method of having a generator unit in the baggage car, taking steam from the locomotive.

THE NEW ENGLAND MOTOR COMPANY, Lowell, Mass., reports brisk business for some time past. In order to meet the demand for its product the company has had to run the factory overtime the greater part of the last six months. Recently booked orders call for twenty two-horse-power motors to go to Chicago, and six special fifty-horse-power size, six-pole machines for the United States Navy.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., general selling agent of the Gutmann integrating alternating-current wattmeter, states that the factory has been enlarged to meet the volume of business and that it is now able to fill orders promptly. The new type wattmeter has a sealed case, making it proof against moisture, dust and insects. It is claimed to be unaffected by atmospheric conditions.

THE ERIE RAILROAD COMPANY has just issued its 1902 book on "Rural Summer Homes." This book is very elaborately got up and filled with handsome half-tone illustrations of summer scenes along the route and vicinity of the Erie. It also contains a complete list of the different summer hotels and stopping places along that road, with prices and the number of guests each hotel can accommodate.

THE OKONITE COMPANY, LIMITED, of New York, at its annual meeting held recently, declared a dividend of six per cent on the stock of the company for the eleven months ending December 31, 1901, which was paid May 10. This company is one of the best known manufacturers of insulated wires and cables for all branches of electrical work, and the dividend just paid is an indication of the fine business it enjoys.

THE AMERICAN CONDUIT MANUFACTURING COMPANY, New Kensington, Pa., is the manufacturer of the "American" iron armored electric wire conduit for exterior and interior use. This conduit, it is claimed, can be bent in any manner without cracking or blistering, being rust-proof and acid-proof. The conduit is formed with thread couplings and does away with slip joints. The "American" elbows are machine made and under approval by boards of fire underwriters.

THE WARREN ELECTRIC AND SPECIALTY COMPANY, of Warren, Ohio, is one of the truly progressive and successful manufacturing companies of the electrical field. Its chief product, the "Peerless" incandescent lamp, is most widely and popularly known, as well as its electric fans and transformers. The company has been compelled to enlarge constantly, beginning in 1893 and enlarging in 1897, 1898 and 1900, and is now building three additional brick buildings. Such pronounced success is an achievement of which the progressive management may well feel proud.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, is preparing to greatly extend its business. The recent reorganization has placed E. P. Breckenridge, a wealthy Toledoan, in interest, C. C. Warren becoming president and treasurer, with E. P. Breckenridge, vice-president, Frank Warren, secretary, and H. B. Warren, chief electrician and engineer. Extensive improvements will be made to the plant. Plans have been prepared for additions, and with property recently purchased the plant will have a total frontage of 621 feet. An electric crane, capable of handling thirty tons, will cover the new building, which will be 165 feet in length. The improvements will cost about $100,000.

THE AUTOMATIC WATER PURIFIER COMPANY, New York city, is the manufacturer of water purifying and softening installations for city waterworks, boiler feed water, manufacturing water, drinking water, etc. A very large number of installations of this description have been placed in operation for prominent firms, both in the United States and in foreign countries. Some of the notable foreign installations are for the Allgemeine Elektricitats-Gesellschaft, Berlin; Union Elektricitats-Gesellschaft, Berlin; Siemens & Halske, Berlin-Charlottenburg; Brown, Boveri & Company, Frankfort; Siemens & Halske, Actien-Gesellschaft Vienna; Ganz & Company, Budapest; Central Elektricitats-Gesellschaft, Moscow.

I. P. FRINK, New York city, who has long been known for the successful installation of all kinds of lighting fixtures, reports among recent export orders the shipment of large church reflectors to Brazil; Chatham, N. B., and Vancouver, B. C., Canada; Manila, Philippine Islands, and Moravian Mission, Blue Fields, Nicaragua, Central America; also window reflectors to Birmingham, England, and to Mexico City, Mexico, and a general order for shades and special closed reflectors and window reflectors to Cape Town, Africa. Mr. Frink carries a large line of electrical and other lighting specialties which particularly invite export business, and will be pleased to send complete catalogues and data to any one interested in these times.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, has recently closed a contract with the Keystone Telephone Company, Philadelphia, Pa., for a switchboard for its third district exchange. The switchboard will consist of seven sections, with an ultimate capacity of 3,000 lines, and a present equipment of 960 lines, 120 incoming and 120 outgoing trunk lines. Included in this contract is all necessary power apparatus, distributing frames, relay racks and the Kellogg sneak-current and lightning-arrester equipment. The former is manufactured under one of the company's patents and differs materially from former types, in that the heating-up process is not dependent upon the resistance of a coil of wire.